

**FACTORS AND MECHANISMS IN L2 WORD  
STRESS ACQUISITION: EVIDENCE FROM  
CHINESE-ENGLISH INTERLANGUAGE**

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## DECLARATION

I hereby declare that this thesis is my own work and that recognition has been given to the references used. It has not been submitted for any degree or examination at any other university.

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22 May, 2006

Signed: 



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## ABSTRACT

The thesis examines the learning mechanism that guides second language (L2) stress acquisition. Two general views are evaluated: (i) UG-based parameter-setting, which claims that L2 stress acquisition is a process of setting an a priori set of metrical parameters, and (ii) input-based statistical learning, which sees the development of L2 stress patterns as a process of statistical extraction based on the distribution of stress patterns in the input data. This issue is addressed through a re-examination of L2 English stress acquisition by speakers of Mandarin Chinese, a tone language. Because Chinese does not have an apparent stress system, the acquisition of L2 English stress in Chinese speakers allows us to extrapolate systematic patterns of L2 stress development independently of the influence of an L1 stress system. In order to obtain primary data for examining the learning mechanisms, we examined two preliminary issues in order to address the main question: (a) can Chinese speakers assign English word stress systematically? (b) to what extent are the patterns attributable to L1 transfer and phonological universals? In addition, age as a non-linguistic factor in predicting L2 phonological acquisition is also tested.

The question of whether Chinese learners can assign stress to English words systematically is first examined in Chapter 3. In a perceptual preference experiment with English non-words, Chinese participants preferred initial stress for  $\sigma$ .CVCC words when they were presented as nouns, but preferred final stress when they were presented as verbs, paralleling the behaviour of the English subjects. In trisyllabic words, some Chinese subjects preferred penultimate stress when the penult was closed by a consonant (CVC) and antepenultimate stress when the penult only

contained a lax vowel (CV). The tendency was stronger when the coda consonant was a sonorant rather than an obstruent. These results clearly indicate that Chinese speakers make generalizations in acquiring L2 English stress rather than just storing it lexically. The tendency for syllables with a sonorant coda to be stressed can be explained either as a universal effect of sonority-weight interaction or as an L1 transfer effect due to the lack of obstruent codas in Chinese. AOA is found to be a good predictor of the L2 learners' sensitivity to stress contrasts conditioned by CV and CVC syllable structure. The connection between syllable structure and stress is further investigated in Chapter 4. The main experiment used trisyllabic non-words and was designed to test whether Chinese learners know that English stress shifts from the antepenult to the penult when the penult contains either a long vowel or a coda consonant. The results show that the Chinese learners preferred penultimate stress when the penult was CVV, CVC or CVVC, indicating that their acquisition follows the universal mapping of syllable structure and stress. However, unlike the English control subjects, the Chinese subjects had a stronger tendency to assign stress to closed syllables, suggesting that the general pattern may be overlaid with L1 effects, as the Chinese vowel system lacks the contrast in tenseness and length.

Finally the learning mechanism which guides the acquisition of L2 English stress by Chinese speakers is discussed. The data show that some Chinese subjects were sensitive to the noun-verb contrast but not to the stress contrast conditioned by the penult of trisyllabic nouns. It is argued that this developmental pattern runs counter to the prediction of the parameter-setting model. If learners had acquired the noun-verb stress contrast via parameter-setting, they would also have acquired the weight implications of CV and CVC, hence the stress contrast in trisyllabic nouns, which is conditioned by the CV/CVC distinction. The observed pattern can however

be explained by the input-based model, which allows independent learning of the noun-verb contrast via statistical learning. Another type of data which favours the input-based account comes from a corpus-based analysis of segmental effects on English stress, which shows that penults tend to be stressed when they contain a certain vowel, regardless of syllable structure. This anomaly was reflected in the L2 learners' data.

# CHAPTER 1

## INTRODUCTION

The main aim of this thesis is to investigate the learning mechanisms behind second language (L2) phonological acquisition. More specifically, we examine the extent to which L2 word stress acquisition is guided by language-specific principles and mechanisms. One model of L2 stress acquisition which has received a great deal of attention is the parameter-setting model, but it is important to note that the majority of studies which provide evidence in support of this model have looked at the acquisition of an L2 stress language by first language (L1) speakers of another stress language. This means that the evidence in support of the model is inconclusive and it leaves open the possibility that, contrary to what has often been argued, the systematic patterns which emerge in the various interlanguages may be direct effects of the respective L1 stress systems rather than those of universal metrical principles and parameter-setting. We therefore suggest that the issue of learning mechanisms in L2 stress acquisition can be approached better when the source language is not a stress language. Here we investigate the learning mechanism issue by collecting experimental data about stress preferences in Chinese-English interlanguage, where Chinese refers to Mandarin Chinese. As a secondary issue, we are also interested in age as a factor behind L2 stress acquisition. This chapter presents the background information that motivates this research, stating the research questions and providing an overview of the thesis.

## 1.1. Background

L2 learners usually exhibit various types of non-target-like patterns when learning the phonological system of a target language. The general consensus reached by many L2 researchers over the past half century is that, although L2 learners produce or perceive the L2 in a non-target-like way, most of these non-target-like patterns do not consist of random mistakes (see Corder (1967) on mistakes vs. errors). Terms such as “idiosyncratic dialect” (Corder, 1971), “approximate system” (Nemser, 1971) and “interlanguage” (Selinker, 1972) have been adopted to reflect the hypothesis that L2 learners actually construct their own version of the language when acquiring an L2, a hypothesis based on the observation that L2 errors are generally systematic. Since the patterns are so consistent, an interpretation of what factors contribute to the interlanguage system is required. Two types of errors which have attracted much attention from L2 researchers are transfer errors and developmental errors. Transfer errors refer to those forms which are obviously related to learners’ native language. Developmental errors refer to those which are independent from both the L1 and the target language but which are nevertheless made by L2 learners from a variety of L1 backgrounds and resemble the developmental patterns of children’s L1 acquisition. These two types of errors are widely reported in previous studies, but the theoretical interpretation of these patterns varies depending on the different theoretical frameworks adopted. In the generative approach, two of the factors which are thought to be significantly related to these two types of errors are the learners’ L1 phonological system and universal phonological principles (Eckman, 2004; Young-Scholten & Archibald, 2000). In the following sub-section (Section 1.1.1), we review the two types of non-target-like patterns in various areas of L2 phonology and see



how they are interpreted theoretically. Importantly, we will also show that our understanding of L2 stress acquisition is still very limited, particularly in terms of its theoretical interpretation. We then proceed to our second sub-section, which introduces two well-studied non-linguistic variables in L2 adult phonological acquisition (age of arrival and length of residence in the L2-speaking context). Finally we direct attention to two general learning mechanisms which L2 learners are said to rely on in order to learn an L2.

### **1.1.1. Linguistic Factors**

#### **1.1.1.1. L1 Transfer**

L1 transfer was initially defined as the process through which L2 learners carry over some habit(s) and feature(s) from their native language when they produce or perceive an L2 (Lado, 1957). It has been widely accepted that the learner's L1 influences the acquisition of L2 phonology, even by those who doubted L1 influence in the area of syntax (Dulay & Burt, 1974; Ioup, 1984; Richards, 1971).

L1 transfer can be positive or negative. Positive transfer facilitates the process of L2 acquisition while negative transfer inhibits it (Lado, 1957). In L2 phonology, however, L1 transfer has almost always been equated with the interference of L1 phonological patterns upon L2 phonological system, i.e., negative transfer (Jenkins, 2000: 107). That is, when native speakers of Language A acquire Language X as a second language, the L2 phonological patterns are characterized by the features of Language A. Similarly, when native speakers of language B acquire Language X, the L2 phonological patterns will be coloured with the features of Language B. It is hard to deny the role of L1 transfer when phenomena reported from

various L1-L2 language pairs can be analysed systematically in terms of the learner's L1. During the past half century, several different L2 phonological phenomena have been reported to be consistent with a learner's L1, including segments, phonotactics, and syllable structures. For example, native speakers of Spanish tend to pronounce English words such as *snob* and *school* as [ɛsnob] and [ɛskul], inserting a vowel at the beginning of these words. This can be attributed to L1 transfer because Spanish does not allow consonant clusters beginning with the fricative /s/ in word initial position (Broselow, 1984: 262). In addition, native speakers of Vietnamese tend to delete coda consonant clusters (e.g., pronouncing *last* as [læ]), which is attributable to the fact that Vietnamese allows no consonant clusters in coda position (Sato, 1984). In terms of phonological processes, the presence or absence of context-sensitive alternations in learners' L1 can be transferred onto L2 as well. For instance, native speakers of German tend to produce the words *bag* and *bed* as [bɛk] and [bɛt] respectively. These learners are thought to be carrying over their L1 syllable-final devoicing rule into L2 English (Eckman, 1977). A further example comes from Spanish, which unlike English does not have a rule which reduces unstressed vowels: this fact is reflected in the tendency for Spanish learners of English to produce the reduced vowel schwa [ə] preceding stressed syllables in English words with a full vowel such as [a] or [o] (e.g., in *ability* and *botanical*) (Flege & Bohn, 1989).

In addition to L2 segments and syllables, the role of L1 transfer is also attested in L2 stress. For example, Spanish learners of English have a tendency to assign stress to the final syllable of an English word when the final syllable is closed by a consonant (e.g., *móuntain* is pronounced as *mountáin*, and *mórpHEME* as *morphéme*). This can be interpreted in terms of the transfer of a Spanish stress rule,



i.e., stress the final syllable when it is closed by a consonant, e.g., *paréd* ‘wall’ (Archibald, 1993a). However, other studies indicate that the transfer occurs in the form of L1 parameter-settings influenced by the Metrical Stress Theory, in which all stress languages can be uniformly analyzed using the same set of metrical parameters (e.g., Hayes, 1981; Dresher & Kaye, 1990). For example, Archibald (1993b) indicates that Hungarian learners of English tend to assign initial stress to English words (e.g., *aróma* is perceived as *ároma* and *agéndá* is perceived as *áagenda*). This is interpreted as the transfer of Hungarian parameter-setting, i.e., in Hungarian, primary stress usually occurs on the initial syllable and this pattern can be theoretically analyzed as “feet are parsed from left to right” and “feet are strong on the left”. In addition to rule-based and parameter-setting accounts, we will show in Chapter 2 that there are simpler interpretations for the L1 transfer (e.g., phonetic similarity). In other words, the interpretations of L1-related errors in L2 stress acquisition vary depending on the theoretical framework adopted in the studies. The theoretical framework is crucial for the assumptions which are made about the learning mechanisms that guide the subsequent L2 stress development.

Although there have been many explanations of L2 phonological difficulties based on the differences between L1 and L2, some accounts focus instead on the similarities between L1 and L2. One proposal by Wode (1983a, 1983b) is concerned with the conditions under which L1 transfer occurs. He proposes the Crucial Similarity Measure (CSM) as a basis for the occurrence of L1 transfer. The CSM states that in order for L1 to interfere with the acquisition of the L2, there must be identifiable similarities between the L1 and the L2, at least in the mind of the L2 learners. Under this view, the various types of L1 transfer imply that learners judge

the segments or syllable structures in the target language to be similar enough to their L1 to make transfer from the L1 possible.<sup>1</sup> This point will be elaborated further below and in Chapter 2 in the cross-linguistic comparison between stress languages and non-stress languages. Here we note that the similarities in the phonetic correlates of stress among stress languages may also contribute to allowing the transfer of L1 stress patterns to occur.

As more and more studies have been carried out, some have reported patterns that are systematic but cannot be explained solely in terms of L1 transfer. In other words, there are some systematic patterns that are neither L1-like nor target-like. For example, Johannsson (1973) studied twenty L2 learners of Swedish from nine different L1 backgrounds, i.e., American English, Czech, Danish, Finnish, Greek, Hungarian, Polish, Portuguese and Serbo-Croatian. Her results showed that although many of the vowel errors were predictable from the subjects' L1s, others were explainable in terms of universal phonological tendencies. Specifically, the five vowels /a/, /ɛ/, /i/, /u/ and /ɔ/ were pronounced with fewest deviations by speakers of all 9 different source languages learning Swedish, which reflects the principle that developing vowel contrasts should be maximally differentiated from each other (Jakobson, 1969). The pattern is also similar to the way that vowels develop in children's speech. In other words, there are other factors in addition to the influence of L1 which contribute to L2 systematic patterns. An analysis based on L1-L2 differences and similarities therefore seems insufficient to account for the patterns which emerge and the difficulties which L2 learners encounter.

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<sup>1</sup>Flege's (1987, 1995) "equivalent classification" echoes this idea

### 1.1.1.2. Phonological Principles

Another major factor which has been considered to be strongly related to L2 phonological acquisition is universal principles of phonology. Typological studies have revealed that some phonological structures are more basic, simpler and unmarked, and these structures are found in many languages; on the other hand, other structures are more complex and marked, and they appear only in some languages (Jakobson, 1941/1968; Trubetzkoy, 1969). Typological universals are defined as “given X in a particular language, we always find y” (Greenberg, 1963: 73). One example of this is that if a language possesses obstruent codas, then it will also have sonorant codas: the presence of obstruent codas entails the presence of sonorant codas; there is no language which possesses only obstruent codas. Since the unmarked property is implied by the marked one (Greenberg, 1966), we say that sonorant codas are unmarked and obstruent codas are marked.

Similar typological universals are also found in syllable structures. All languages have CV syllables but not all languages have CVC, CCV or CVCC (Spencer, 1996: 82). Thus, CV is unmarked relative to other complex syllable structures. Markedness claims are also based on language processes (Greenberg, 1974). For instance, in the process of neutralization, one feature will be neutralized more often than the other feature, such as [+voice] as opposed to [-voice]. In Catalan, voiced obstruents become voiceless in word final position (e.g., *əmiɡə* ‘friend (fem)’ vs. *əmiḱ* ‘friend (masc.)’). Final devoicing is also found in other languages such as Turkish and German. Since there are no known languages in which the process operates in the opposite direction, [+voice] in obstruents is said to be more marked with respect to [-voice].

There is also a parallel between phonological universals (e.g., markedness) and phonological acquisition (i.e., L1 and L2). For example, children prefer unmarked structures at the initial stage of production (e.g., they tend to omit codas and devoice final obstruents in early production), and then they gradually acquire the more marked ones such as complex syllable structures and voiced coda contrasts (e.g., Demuth & Fee, 1995; Fikkert, 1994). The development from unmarked to marked is thought to be one of the effects of phonological universals. In the case of L2 phonological acquisition, some studies, as we shall see below, have found that phonological universals such as markedness can provide an adequate account of the patterns that are independent of learners' L1 and L2. Some studies have also found that learners' difficulties can best be predicted if the markedness proposed by phonological theories is taken into account. We now present some studies which have reported the effect of phonological universals on L2 acquisition.

The effect of markedness has been reported in the acquisition of L2 segments and syllables. Let us look at two examples of markedness effects on L2 segmental acquisition. German and English are different from each other with respect to voice contrasts in coda consonants. Whereas in English there is a voiced/voiceless contrast in coda consonants, in German the voiced/voiceless contrast is neutralized. Logically speaking, what native speakers of English have to learn about German codas is that they must neutralize the voiced and voiceless consonants by devoicing the voiced codas; on the other hand, what native speakers of German have to learn about English codas is that they must maintain the voiced/voiceless contrast. Empirical evidence shows that more difficulties are found in native speakers of German acquiring English than in native speakers of English acquiring German (Moulton,



1962)<sup>2</sup>. This asymmetry is further explained by some L2 acquisition hypotheses, one of which is Eckman's (1977) Markedness Differential Hypothesis (MDH). The MDH incorporates the idea of markedness to improve the ability to predict learner difficulties caused by L1-L2 differences, and claims that not all differences between L1 and L2 cause learners difficulties: only those areas in the target language that are more marked than the native language will be difficult. Specifically, since voiced codas are universally more marked than voiceless codas in word-final position, the task encountered by native speakers of German when they learn English is a relatively more challenging one than the one encountered by native speakers of English who learn German. In other words, since the difference between German and English is an unmarked one for native speakers of English, it is less difficult for them to learn.

The effect of universals is also observed when L2 learners acquire phonological structures that are absent in their L1. Universally, complex coda clusters (e.g., -CCC) imply simpler coda clusters (e.g., -CC). The fact that simpler consonant clusters are acquired before complex ones by Japanese, Korean, and Cantonese speakers shows the effect of universals since none of these languages allows consonant clusters in the coda position (Carlisle, 1997, 1998; Eckman, 1991; Eckman & Iverson, 1994). This is further formalized in L2 acquisition theories, for example, Eckman's (1991) Structural Conformity Hypothesis (SCH), which extends the explanatory power of universals to L2 phonological difficulties that are not directly related to the differences between L1 and L2. The SCH suggests that "the universal generalizations that hold for primary languages hold also for

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<sup>2</sup> Young-Scholten (2004) shows that the learning of final devoicing in German by English speakers is not straightforward since the learner first has to determine whether the coda consonant is underlyingly voiced or voiceless.

interlanguages” (Eckman 1991: 24). The SCH predicts, for instance, that simpler consonant clusters such as -CC will be acquired before complex ones such as -CCC in L2 phonology since phonological universals show that -CCC implies -CC.

In L2 syllables, Tarone (1980) suggests that the universality of open syllables plays a role in L2 phonology. As mentioned, CV is unmarked relative to other syllable types (such as CCV, CCCV and CVC). In L2 acquisition, it has been shown that learners prefer the less marked CV in L2 even if their native language has the more marked CVC. Using native speakers of Cantonese, Korean and Portuguese learning L2 English, Tarone (1980) argues that a number of learners’ errors are not directly attributable to their L1; instead, they modify syllables that the L1 allows. For instance, it is reported that Korean speakers sometimes modify words ending in a coda consonant by adding a vowel after the coda consonant (e.g., *sack* is produced as [sæke]) even if CVC is a permissible sequence in Korean. The modification of L2 English codas suggests that the learners have a preference for open syllables, which is a universal preference.<sup>3</sup> A similar finding of a preference for open syllables is also reported by Hodne (1985) from the data of Polish learners of English.

Let us now consider an example of phonological universals where there is an interaction between segments and syllable structures. As mentioned, voiced obstruent codas are considered more marked than voiceless obstruent codas according to typological observations. This marked/unmarked difference is also observed in the acquisition of L2 syllables of the type CVO(bstruent). In Mandarin Chinese,

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<sup>3</sup> This conclusion by Tarone (1980) has been questioned by Broselow and Park (1995) who observe that the tendency towards epenthesis depends on the quality of the vowel preceding the final consonant. For instance, Korean learners of English do not always epenthesize a final vowel. Epenthesis occurs when the vowel is long (e.g., *beat* → [bitə]), but not when it is short (e.g., *bit* → [bit]). They argue instead that this is an effect of moraic preservation.

although the syllable structure CVC is allowed, only the sonorant consonants /n/, /ŋ/, and /r/ are permitted in coda position. It is reported by Eckman (1981) that Chinese learners of English do not treat all English CVO words in the same way: more vowel insertions occur in cases such as *tag* when the obstruent coda is voiced (e.g., [tægə]), compared to cases such as *deck*. This tendency is accounted for by the fact that voiced obstruent codas are more marked than their voiceless counterparts. The markedness of the voiceless obstruent in the coda influences whether the target CVC is maintained as CVS(onorant) or modified to become the unmarked CV structure (i.e., [tægə] is a CV.CV sequence). Similar findings are also reported by Broselow, Chen, and Wang (1998), who use Optimality Theory to explain the interaction between L1 transfer and the unmarked.

As well as influencing how L2 coda consonants are acquired, universals also determine the order of acquisition of onset clusters. Segments may vary from each other in terms of sonority, (an indication of the prominence related to their intrinsic loudness). The classes of consonants can be hierarchically ranked from more sonorous to less sonorous, that is, glides (5) > liquids (4) > nasals (3) > fricatives (2) > stops (1) (Selkirk, 1982). Whether or not a certain type of consonant cluster is permitted in a language can be elaborated in terms of the Minimal Sonority Distance (MSD). According to Broselow and Finer (1991), the MSD refers to the required degree of difference in sonority value between adjacent segments in the onset or coda. Languages may differ in MSD. The smaller the MSD, the more marked it is. This means that the presence of any cluster implies the presence of a cluster with greater sonority distance. For example, the presence of the stop-liquid sequence in English (e.g., *proof*) implies the presence of the stop-glide sequence (e.g., *pure* /pjur/) since

the MSD of the latter is larger than that of the former. However, the stop-nasal sequence (e.g., \*pno) is not permitted in English because the MSD is smaller than the setting value that English permits. In relation to L2 phonology acquisition, this implies that onset clusters with greater sonority distance are acquired before clusters with less distance. For example, Cy (e.g., *pure*, *future*) would be acquired before Cr (e.g., *Bruce*, *prune*), and within the class of Cr, /pr/ would be acquired before /fr/. Both Korean and Japanese allow Cy onset clusters but not Cr; therefore, Cr is predicted to be more difficult for the speakers of these two languages acquiring L2 English. Interestingly, Broselow and Finer's data show that their Korean and Japanese learners of English set a value of MSD which is neither their L1-like nor English-like but is something in-between (e.g., /pr/ is allowed but /fr/ is not allowed). This pattern can be interpreted as these learners' establishing their own version of L2, one which is consistent with phonological universals, where the MSD is smaller than their L1 but larger than English.

A further piece of evidence for universals comes from the finding that L2 learners apply the acquired L2 phonological rules within prosodic domains which are neither target-like nor L1-like but which are found in the universal prosodic hierarchy. Young-Scholten (1994) reports data of this kind from German learners of American English. Flapping in American English (e.g., *butter* [bʌɾər]) applies within several prosodic domains in the prosodic hierarchy, including intonational phrases, phonological phrases, clitic groups, and derived and underived phonological words. She found that while her three German-speaking advanced learners could almost always produce flapping in smaller prosodic domains such as clitic groups and derived and underived words, they only did so occasionally in larger prosodic



domains such as phonological phrases and intonational phrases. Even though they did not apply flapping as native speakers of English do, they did so in a systematic manner, i.e., applying it more within lower domains of the prosodic hierarchy. As resyllabification in German occurs within clitic groups as well as in all lower domains, this pattern is left unexplained by L1 transfer, but the prosodic domains within which English flapping applies in German-English interlanguage do reflect universals of the prosodic hierarchy.

So far, we have presented several phenomena from segments, syllable structures, and prosodic domains which show evidence for the effect of phonological universals in L2 phonology. To date, however, it is not clear whether there is also an effect of universals in the acquisition of L2 stress, since this topic has not been comprehensively studied so far and the findings in the existing literature are inconsistent. To our knowledge, there is only one study of L2 stress acquisition which reports patterns that are independent of L1 and L2, namely, Pater (1997). In this study French learners of English produced L2 stress patterns which were different from both French and English, i.e., assigning primary stress on the initial syllable of both tri-syllabic and quadri-syllabic words. Since this pattern follows the principle of metrical phonology, it was taken as evidence that metrical principles play a role in L2 stress acquisition. However, there is an alternative account for Pater's finding available in terms of L1 transfer; a more detailed review of this study will be presented in Chapter 2.

### **1.1.2. Non-linguistic Factors**

After reviewing linguistic factors related to non-target-like patterns in L2 phonological acquisition (i.e., L1 and phonological principles), we now move on to review non-linguistic factors which are considered to play an important role in L2 phonological acquisition.

A great deal of debate has been generated over the years on the issue of whether complete attainment is possible in adult second language acquisition (see a review by Piske, MacKay & Flege, 2001). In predicting the perceived foreignness of L2 pronunciation, the two variables which are considered to be effective are age of arrival (AOA) and length of residence (LOR). In the following discussion we provide a brief review of these two factors, addressing the issues of whether L2 learners' ability to acquire native-like phonology declines gradually or catastrophically, the putative age that a person must be exposed to an L2 by if native-like phonology is to be guaranteed, and whether or not LOR is an effective predictor of L2 foreign accent.

#### **1.1.2.1 Age of Arrival**

In L2 speech, perceived foreign accent is often used as an index for the degree of success with which a new language has been acquired. Foreign accent refers to the degree of L2 learners' non-target-like pronunciation as perceived by native speakers of the target language. In most previous studies of this question, as we will see below immediately, subjects were recorded as they read written materials aloud, described some personal experience, or repeated speech materials. Native speakers of the target language were then asked to evaluate the recorded L2 speech samples using a rating

scale to indicate the degree of foreign accent they perceived. Subjects' age of arrival (i.e., age of first exposure to a predominantly L2-speaking country) was found to strongly correlate with L2 foreign accent perceived (i.e., the earlier in life one learns an L2, the better it will be pronounced) (e.g., Asher & Garcia, 1969; Fathman, 1975; Flege & Fletcher, 1992; Oyama, 1976; Patkowski, 1990; Tahta, Wood, & Loewenthal, 1981; Thompson, 1991)

A relevant question to ask is whether age-related ability in learning a new language declines gradually or sharply. Both views are found in the literature. It is often suggested that there is a critical period for human speech learning, during which there is a loss of neural plasticity, and if L2 learning begins after this critical period is past, successful acquisition is usually regarded as impossible (e.g., Lenneberg, 1967; Patkowski, 1980, 1990; Scovel, 1969, 1988). According to the critical period hypothesis, a clear difference should be seen between foreign accent ratings obtained for individuals who began learning the L2 during the critical period and those who began learning once the critical period was past. However, a number of studies have shown that the effect of AOA on L2 learners' target-like pronunciation declines gradually. The gradual increase in degree of L2 foreign accent with increasing AOA made both Oyama (1976) and Long (1990) suggest the term "sensitive" is more accurate than "critical" for L2 learning. In addition, different suggestions have been made as to when the critical or sensitive period for L2 speech learning ends; Scovel (1988) suggested the age of 12 years while Patkowski (1990) suggested 15 years. Long (1990) indicates that an L2 is usually spoken without foreign accent if it is learned by the age of 6 years, but foreign accent would be detected in most learners who begin learning after the age of 12 years. In

contrast to the view that some sort of biologically-determined critical period does exist (whether it shuts down suddenly or gradually), some researchers have sought other explanations, bearing in mind particularly the observation that an AOA of less than 6 years does not always guarantee accent-free L2 speech. Flege, Frieda and Nozawa (1997), for example, identify the amount of L1 use as another factor which has a bearing on L2 speech accent even for learners whose AOA is less than 6 years. In their experiment, two groups of early Italian-English bilinguals were matched for AOA (6 years on average) but differed in the extent to which they used the L1. The groups were found to have different degrees of foreign accent, and specifically, the group of subjects who had used the L1 (Italian) intensively had more of a foreign accent.

In summary, previous research has shown that early learners speak L2 with a lower degree of foreign accent than late learners. However, there are some controversies about whether the ability is lost gradually or sharply and the age which is said to guarantee the complete attainment of L2 phonology. Later in this thesis we will examine whether AOA plays a role in predicting the degree of success with which L2 English stress is acquired by L1 Chinese speakers.

#### **1.1.2.2. Length of Residence**

In addition to AOA, another important non-linguistic variable has been “length of residence” (LOR), that is, the number of years that L2 learners have spent in the community in which L2 is the predominant language. While the effect of AOA is widely acknowledged in the literature, previous research has produced somewhat mixed results on the effect of LOR, with studies disagreeing on whether a correlation

can be found between LOR and the foreignness of the L2 accent. Studies that have reported an influence of LOR on L2 foreign accent include Asher and Garcia (1969), Purcell and Suter (1980), Flege and Fletcher (1992), Flege, Munro, and MacKay (1995) and Flege, Yeni-Komshian, and Liu (1999). However, several studies that have not found an effect of LOR include Oyama (1976), Tahta, Wood and Loewenthal (1981), Flege (1988), Piper and Cansin (1988), Thompson (1991), Elliott (1995) and Moyer (1999). It has recently been argued that the discrepant findings on LOR effects can be unified under one interpretation: it is possible that both LOR and AOA are predictors at the early stages of L2 acquisition, but the effects of LOR taper off in later stages (Piske, MacKay, & Flege, 2001). This is because no matter how young L2 learners are when they arrive in the community of the target language, if they have not been exposed to the L2 long enough, their proficiency cannot be particularly high. We would also point out that much of the research on the age effect looks at 'global accent' rather than the specifics of the L2 phonological system. Investigating age effects in L2 stress development can tell us how AOA and LOR might affect a particular aspect of L2 acquisition, and potentially, what types of learning mechanisms are affected the most by age effects. In chapter 3, we will have an opportunity to see if AOA and LOR act as predictors in the acquisition of L2 English stress by native speakers of Chinese.

### **1.1.3. Learning Mechanisms**

Having considered how L2 phonological patterns are related to both linguistic factors (L1 and phonological universals) and non-linguistic factors (AOA and LOR), we now turn to our main interest, that is, the learning mechanisms that underlie the



ability of L2 learners to acquire L2 phonology. The discussion will be focused on two of these mechanisms in particular: the UG-based parameter-setting approach and the input-based statistical learning approach.

### **1.1.3.1. UG-based Parameter-setting**

One view which has been dominant in generative linguistics is that language acquisition is best characterised as the unfolding of highly specified innate abilities (Chomsky, 1981). Specifically, this view assumes that there is a set of a priori principles and parameters of Universal Grammar (UG) in the learner's mind when learners come to the language-learning task. The initial state of language acquisition comprises unmarked structures, invariant principles, and parameters with limited choices of settings. Under this view, learners' preference for unmarked structures such as CV syllables at the earlier stages of acquisition is regarded as the emergence of the unmarked. There are also some fixed principles (e.g., the metrical principle stipulating that prosodic words consist of feet, which are constructed from syllables), and these principles do not have to be learned. The parameters of UG can be exemplified by the following case in syntax. Typological surveys show that languages differ from each other in systematic and limited ways, which can be accounted for in terms of parameters. In syntax, the parameter [null subject] has two setting: languages can be either [+null subject] or [-null subject] (Chomsky, 1981). Languages with the [+null subject] setting allow subject pronouns both to be omitted and to appear overtly. Example (1.1) shows two grammatical Spanish sentences: one with an overt pronoun as in (1.1 a) and the other without an overt pronoun, as in (1.1 b), where *pro* refers to the omitted pronoun.

- (1.1) a. *él* es inteligente.  
           he is intelligent.  
       b. *pro* es inteligente.  
           (he) is intelligent.

Languages with the [-null subject] setting require the pronoun subject to be overt. English is a language of this type, as shown in (1.2), where the sentence with an overt pronoun is grammatical, but the other sentence with the pronoun omitted is ungrammatical.

- (1.2) a. He is intelligent.  
       b. \**pro* is intelligent.

The theory of parameter-setting assumes that a learner comes to the task of acquiring language with this parameter and its binary setting values, and input data serve only to trigger the appropriate setting of the parameter depending on the language to which he or she is exposed (Hyams, 1986). The next question to ask is how learners determine whether a language is [+null subject] or [-null subject]. Would it be the case that learners initially choose one of the two possible values provided, or is there a default setting of this parameter? These questions form the issue of learnability in language acquisition. The distinction between positive and negative evidence is crucial for the issue of a default setting. Positive evidence is defined as observable properties from input data, and negative evidence refers to information about ill-formed or unlicensed structures in the target language. Children are usually believed to have access to positive evidence only, not negative evidence, in their L1 acquisition (Pinker, 1989; Marcus, 1993). This assumption leads to the conclusion that the default setting for this parameter is [-null subject] (e.g., White, 1985). The setting [-null subject] generates only sentences with an overt pronoun while the other

setting [+null subject] generates sentences with an overt or omitted pronoun. If learners start off from [-null subject], but encounter a [+null subject] language, they can reset the parameter via positive evidence. That is, if the language they are exposed to is Spanish, input data would inform learners about the existence of subjectless sentences like (1b), which would trigger the re-setting of the parameter to [+null subject]. When learners are exposed to a language like English, on the other hand, the default setting, [-null subject], remains unchanged, because it is compatible with the grammar of the ambient language. However, if the default setting were [+null subject], learners would probably never learn a language with [-null subject] (e.g., English) unless negative evidence is available. This is because [+null subject] generates a wider grammar which allows both overt and omitted pronouns. Having [+null subject] as the default setting means that learners regard both sentences with overt pronouns and sentences with omitted pronouns to be grammatical from the very beginning. If learners are exposed to languages like Spanish, the setting of [+null subject] remains unchanged, allowing them to produce sentences with either an overt or an omitted subject. However, if the learner is exposed to a [-null subject] language like English, which allows only overt pronouns, they would never detect that sentences with omitted pronouns are ungrammatical unless they were told so – that is, by encountering negative evidence. In short, based on learnability considerations and the assumption that negative evidence is not available, the setting value of a parameter which generates the more restricted grammar is regarded as the default setting.



Some parameters do not have a default setting since there is no obvious superset-subset relationship between the possible settings.<sup>4</sup> In this case, the parameter is not set until a suitable cue is detected from input data. Some of the metrical parameters which govern stress assignment have default settings while others do not (Dresher & Kaye, 1990), an issue which will be discussed in more detail in Chapter 2. This parameter-setting approach has also been applied to L1 prosodic development (Dresher & Kaye, 1990; Fikkert, 1994).

The knowledge constructed by means of parameter setting has a number of particular characteristics. Firstly, the well-formedness defined by the core grammar is expected to be categorical, distinguishing absolutely what is possible in the grammar from what is impossible. In particular, exceptional cases are considered to be individually stored in the lexicon and do not trigger the setting of parameters (Dresher & Kaye, 1990). In addition, learners may produce something independent of the L2 if they mis-set one or more parameters due to misanalysing the input data. Meisel (1995) states that although English is a [-null subject] language, many English sentences are subjectless in casual speech, which might mislead learners to hypothesize that the setting in English is [+null subject] at some developmental stage. A similar case is reported in the acquisition of L2 English stress by French learners, when the parameter of Word headedness is mis-set (Pater, 1997). For example, native speakers of French prefer the English nonword *mandadekstra* to have primary stress on the initial syllable and secondary stress on the penultimate syllable (i.e., *mándadèkstra*), a preference which can be analyzed as mis-setting the Word headedness parameter as “left” instead of with the English value, “right” (i.e.,

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<sup>4</sup> A subset in this context refers to a grammar generated by the parameter-setting which allows more restricted structures whereas a superset refers to a grammar generated by the parameter-setting which allows a wider range of structures (Wexler & Manzini, 1987)

*màndadákstra*). This study will be discussed further in Chapter 2, where we will show that this feature of French-English interlanguage is not after all a clear-cut case of parameter mis-setting.

In the case of L2 acquisition in general, there has been some debate about whether L2 learners start from default settings or from L1 settings (see the discussion in White (2003) and references there). Regarding the acquisition of L2 English datives by French speaking learners, Mazurkewich (1984) claims that non-advanced L2 learners typically use the unmarked structure (i.e. the NP PP form, because verbs which take NP NP also allow NP PP). However, the re-analysis of Mazurkewich (1984) in White (1989) showed that this is more likely to be a case of L1 transfer. This debate is also found in the specific area of adult L2 English stress acquisition. Archibald (1993b) suggests that Hungarian and Polish speaking learners of English transfer their L1 setting and do not go back to the default setting. For instance, under Archibald's analysis, although by default the parameter Quantity-Sensitive-to [Rhyme/Nucleus] is set to Quantity-Sensitive-to [Rhyme] (Archibald, 1997: 52), he found that beginning Hungarian learners of English show the L1 pattern Quantity-Sensitive-to [Nucleus] instead (e.g., they were more accurate in perceiving stressed syllables with a long vowel such as *aróma* compared to stressed syllables with a coda consonant such as *agéndá*). A similar argument is made by Van der Pas and Zonneveld (2004): after reanalysing Pater's (1997) results they suggest that French learners of English show patterns of moving from default settings to marked settings. L2 stress will also be discussed in greater detail in Chapter 2.

### 1.1.3.2. Input-based Statistical Learning

Another view of language learning, one which is opposed to the UG-based parameter setting model, sees L2 acquisition as a domain-general learning process. The basic assumption is that language learning is similar to learning other things in the environment. Hence, there are no a priori abstract principles or parameters that are specific for the purpose of language acquisition. In adult L2 acquisition, two kinds of phenomena have been used to challenge the claim that L2 acquisition is domain-specific: (1) the emergence of ‘wild grammar’ which is not permitted with UG (Clahsen & Muysken, 1986) (e.g., headless PPs (Klein, 1995)), and (2) the lack of uniform success among learners, indicating that L2 learners may employ “general problem-solving skills” rather than UG-based learning mechanisms specific to language when they acquire an L2 (Bley-Vroman, 1989; Schachter, 1988). A more concrete concept than “general problem solving skills” as a domain-general mechanism is statistical learning. Under this view, language acquisition is seen as a process of statistical extraction based on the distribution of phonological patterns in the input data.

Statistical learning is domain-general in the sense that it is used both in learning language and in non-language skills and it is possessed not only by human beings but also by non-human primates. There is now much evidence that infants use statistical information to acquire various aspects of human language. Saffran, Aslin, and Newport (1996), for example, investigated 8-month-old infants’ word segmentation in a corpus of artificial speech. They noted that in natural speech, adjacent sounds that co-occur with a high probability are usually found within words, whereas low probability sound pairs tend to span word boundaries. This difference in

the likelihood of sounds co-occurring provides potential information for word boundaries, and may contribute to early language acquisition by bolstering the ability to segment the speech stream into meaning units. Saffran and his colleagues show that 8-month-olds can extract “words” based on the co-occurrence probabilities of segments. Furthermore, Saffran, Johnson, Aslin, and Newport (1999) found that 8-month-olds detected transitional probabilities of non-linguistic tone sequences, an indication that statistical learning is not a purely linguistic learning mechanism. Nor is this ability species-specific: Hauser, Newport, and Aslin (2001) found that it is also possessed by non-human primates. After exposure to the same set of auditory stimuli employed by Saffran, Aslin, and Newport (1996), adult cotton-top tamarins showed reliably greater interest in non-words than in familiar words, suggesting that they were able to extract the statistical information defining word boundaries in the artificial speech, in a similar manner to human infants. These experiments imply that statistical learning may be a general purpose learning device which is also used in language learning.

Input-based statistical learning has also been applied to studies of L2 word stress acquisition. Davis and Kelly (1997) suggest that part of English stress patterns can be learned simply by extracting statistical facts in the English lexicon. The lexicon consists of lexical entries and thousands of relationships between sound patterns and their syntactic and semantic information, and these relationships are usually arbitrary (see Pinker, 1994 and references therein). It is suggested that general properties of learning and memory rather than language-specific operations are involved in learning the associations between sound and meaning that characterize the lexicon. For example, the noun-verb stress difference is one of many



phonological correlates to grammatical class that exist in the English lexicon (Kelly, 1992). The apparent superficiality of linguistic patterns like the English noun-verb stress difference and their cross-linguistic arbitrariness make them unlikely candidates for inclusion in any core language learning theory. They may therefore be learned instead through a general ability to detect correlations between objects and events in the environment. In other words, some phonological patterns may be learned from the distributional facts of the lexicon of a particular language.

Based on this discussion, it is clear that input-based statistical learning and UG-based acquisition have different focuses. UG-based acquisition is mainly concerned with how linguistic forms are acquired, so learning theories such as parameter-setting focus on what kind of evidence could lead to the setting of parameters or in what order a set of parameters should be set. Under this view, input data functions to trigger those innate formal structures, and variations and exceptions are ignored. On the other hand, the input-based statistical learning theory places emphasis on characteristics of the input data such as distributional facts and variations and how these factors could contribute to language learning. However, although the two learning mechanisms provide very different interpretations of the process of language acquisition, they are not mutually exclusive in every respect. For instance, it is not necessary for input-based statistical learning to exclude the notion of linguistic representations. Davis and Kelly's (1997) study shows that the noun-verb stress contrast can be learned via statistical learning, but the learning is still based on some sort of linguistic forms (e.g., syntactic categories and phonological cues). The crucial difference, therefore, lies not in how the linguistic elements are analyzed, but in how the learner is seen to learn their relationships.



## 1.2. Research Questions

Having reviewed the necessary background information in Section 1.1, this section outlines the differences between stress and non-stress languages, in the light of our understanding of L2 stress acquisition from the review presented above. We then go on to present the research questions which we posed in this thesis as a means of addressing our main purpose, i.e., the comparison of the two learning mechanisms which have been posited for L2 stress acquisition.

As we will show in Chapter 2, although there is clear evidence that native speakers of a stress language can acquire the stress system of an L2 systematically, the learning mechanisms behind this systematicity are still unclear. We have already seen that L1 transfer is found across typologically identical language pairs (such as Polish-English and Hungarian-English), but it is hard to determine the depth of the transfer: it is unclear whether L1-related patterns are caused by the transfer of the surface stress placement in the learners' L1 (due to the phonetic similarities between stress languages, for example), or whether they also involve the transfer of abstract metrical parameter settings from the L1. Again, several studies have shown that some L2 learners are able to acquire target-like stress patterns, but here too the theoretical interpretations of the learning mechanisms behind this achievement vary, with some researchers viewing the target-like forms as evidence for parameter-resetting from the L1 value towards the L2 value, while others argue that they are learned using domain-general learning abilities such as statistical extraction. Therefore, it seems that data from L2 stress patterns by L1 non-stress language speakers allow us to abstract away from the transfer of surface stress patterns to a greater extent, and it also allows us to investigate the learning mechanisms behind it.

In the following, we briefly introduce what so-called stress and non-stress languages refer to.

Languages are often classified according to three basic lexical prosody phenomena: tone, pitch-accent and stress (Beckman, 1986). Lexical tone refers to prosodic systems in which pitch height and contour shape are used to distinguish one word from another. Mandarin Chinese for example, is a tone language, whose tonal system has four lexically contrastive (or phonemic) tones, i.e., high level, rising, low, and falling (e.g., Chao, 1968; Cheng, 1973). In this language, the syllable /ma/ means 'mother' when its pitch height is high level, 'hemp' when it is rising, 'horse' when it is low, and 'scold' when it is falling. The second type of language has lexical pitch-accent: one syllable per word is made prominent by means of a specific pitch height. Japanese is a typical pitch-accent language; in Japanese the syllable that carries the lexical pitch accent is marked by a fall in pitch height. For example, when the word *ikoo* means 'after', its pitch accent occurs on the first syllable, followed by a fall on the second syllable. On the other hand, when *ikoo* means 'go', its pitch accent is on the second syllable, followed by a fall on the third syllable, and the first syllable gets a default low automatically. Languages with lexical stress, thirdly, have a system in which lexical prominence is featured by prosodic correlates other than specific pitch height. English is a language of this type: one syllable is made more prominent than the others by the fact that it has longer duration, higher intensity and perhaps a less centralized vowel; and although the stressed syllable may also have higher pitch, this is not always the case. In other words, languages with lexical stress do not use pitch height in a lexically specific way, unlike languages with lexical pitch accent and lexical tone. In contrast to lexical tone languages, there is an area of common ground

shared by languages which have lexical pitch accent and lexical stress, in that one syllable per word is more prominent than the others. Lexical pitch accent languages and lexical stress languages differ from each other in how they implement prominence phonetically (i.e., whether through pitch height or other prosodic parameters), but among the three language types, these two are closer to each other than they are to lexical tone languages (although it has been argued that lexical tone languages can also have word-level prominence (e.g., Remijsen, 2002)). This point is relevant to our research since it has sometimes been proposed that there is some sort of similarity requirement between L1 and L2 in order for L1 transfer to occur (as mentioned in the discussion of the CSM in Section 1.1.1.1). An empirical question that arises is whether or not L1 transfer is more likely to occur in the acquisition of L2 stress by native speakers of stress languages, compared to the acquisition of L2 stress by native speakers of non-stress languages (i.e., pitch accent and tone languages) because stress languages share common prosodic parameters. It is also testable whether or not native speakers of pitch accent languages are more likely to transfer aspects of their L1 metrical system than native speakers of tone languages because of the similarity between stress languages and pitch-accent languages. If this idea is valid, L1 transfer would be least likely to occur in the acquisition of L2 stress by native speakers of tone languages because the implementation of pitch height in tone languages is very different from that in the other two types of languages. This study will not test all of these questions, even though the typological difference is an important concept in the interpretation of the transferability of L1 lexical prosody into L2 stress, which we will review in Chapter 2. Instead, one of the aims of this study is to investigate in more detail whether or not the phonological system of a

tone language (i.e., Mandarin Chinese) can or cannot influence the acquisition of L2 stress by adult learners.

As previously stated, learning mechanisms can be better investigated if the source language and the target language differ in their lexical use of pitch. Since Mandarin Chinese is conventionally classified as a lexical tone language, the use of empirical data on the stress patterns seen in Chinese-English interlanguage will allow us to avoid some of the thorny theoretical problems which arise when both the L1 and the L2 are stress languages. In the present study, English was selected as a target language because the descriptive facts of English stress patterns are well-documented and because the theoretical analyses have been elaborated in phonological theories of metrical stress, providing a firm foundation for acquisition studies. Moreover, since research in L2 stress acquisition has mostly been carried out with English as a target language, we will be able to compare our results with those from previous studies. More importantly, English stress provides an ideal testing ground for learning mechanisms because, while its patterns are basically regular, it also contains a number of exceptions. So although its stress system has been analyzed under the generative framework, its actual distribution is in fact probabilistic, and this is what allows us to test whether L2 English stress is acquired via parameter-setting or statistical extraction.

Our strategy for investigating this was to ascertain whether it is possible for any systematic patterns to emerge in English word stress as learned by speakers of a non-stress language (namely, Mandarin Chinese). Then we examined the extent to which those patterns are attributable to the L1 or to proposed linguistic universals (such as the WSP). Taking those as our basic findings, we then analyzed the data



from the perspective of learning mechanisms to see whether they have a better fit with the parameter-setting model or the statistical learning model. In the meanwhile, we also examined the effects of age as a possible factor affecting the process of L2 stress acquisition. In short, there are four research questions in this thesis:

- 1. Can L1 Mandarin Chinese speakers acquire L2 English word stress in a systematic way?**
- 2. To what extent can these learners' errors be attributed to their L1 and proposed phonological principles?**
- 3. What kind of learning mechanism guides the acquisition of L2 stress by native speakers of a tone language?**
- 4. Are there age-related effects (AOA and LOR) in L2 stress acquisition?**

The first two questions aim to explore the general English stress patterns acquired by native speakers of Chinese, and the final two questions address the main concerns of this study.

This in-depth study of Chinese-English interlanguage will contribute towards expanding the available empirical data on L2 stress acquisition, which at this time comes mostly from learners whose L1 is also a stress language. Although there are a few studies on the acquisition of L2 English stress by non-stress L1 speakers (e.g., Japanese-English by Kawagoe (2003) and Akita (2001)), interlanguages created by pairing stress languages still dominate as the data source in theories of L2 stress acquisition. Systematic examination of Chinese-English interlanguage should therefore prove very informative when the results are compared with the general findings from more frequently studied language pairs.



### 1.3. Thesis Overview

The remaining chapters of this thesis are organized as follows. In Chapter 2, we review previous studies of L2 English stress acquisition. We introduce the basic characteristics of English word stress, and how it is interpreted linguistically both from within the approach which assumes metrical parameters and the approach which does not assume them. We then review previous research on the acquisition of L2 English word stress by native speakers of stress languages and non-stress languages, focusing particularly on attested patterns, theoretical accounts from the perspectives of L1 transfer and universal principles, and learning mechanisms.

Chapters 3 and 4 present a series of perceptual experiments with non-words presented auditorily, which were conducted to obtain primary data for the investigation of learning mechanisms in Chapter 5. Chapter 3 presents the first experiment, which aims to re-examine whether Chinese learners can learn L2 English stress in a systematic way, as opposed to simply storing the stress patterns of individual words. If systematic patterns emerge in the data, this will allow us to address the two questions of interest listed above: the extent to which the L2 stress patterns can be attributed to the effects of the learners' L1 and universal phonological principles, and whether there is any age effect in L2 learners' English stress patterns. The connection between syllable structure and stress in Chinese-English interlanguage is further investigated in the experiments of Chapter 4.

Chapter 5 presents a general discussion of the findings obtained from Chapters 3 and 4, with a focus on evaluating which learning mechanism best characterizes the acquisition of L2 English stress by native speakers of Mandarin Chinese. We then discuss the broader implications of this study for L2 stress

acquisition research as a whole. Finally, Chapter 6 describes some further issues and concludes the whole thesis.

## **CHAPTER 2**

### **OVERVIEW OF L2 WORD STRESS ACQUISITION**

This chapter aims at presenting an overview of relevant work on L2 English word stress acquisition, focusing on three issues: L1 transfer, the role of metrical principles and learning mechanisms. Section 2.1 provides a brief introduction to English word stress and its phonological analyses, including one analysis which assumes metrical parameters and one which does not. Section 2.2 reviews previous studies on the L2 acquisition of English word stress by native speakers of stress languages and native speakers of non-stress languages. Section 2.3 presents a critical evaluation of previous studies. Since Mandarin Chinese serves as the source language investigated, Section 2.4 briefly introduces some characteristics of Chinese phonology. Section 2.5 summarizes the chapter as a whole and reformulates the research questions of the current study.

#### **2.1. English Word Stress**

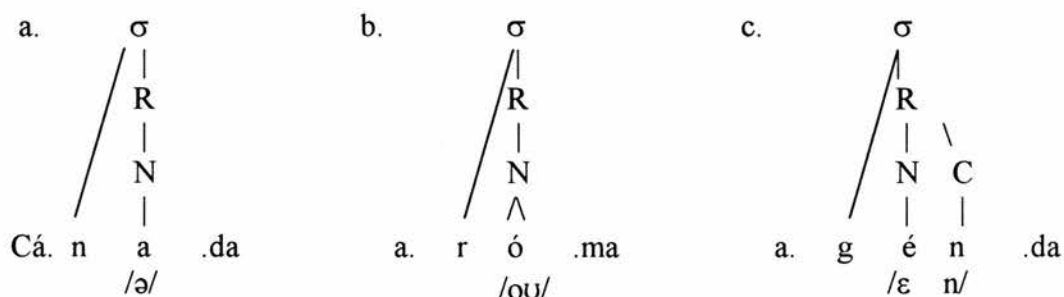
This section briefly introduces stress patterns in English mono-morphemic words, which are the topic of interest of this study. Basic generalizations are provided first, followed by two types of theoretical analyses. The first analysis is based on metrical parameters. Therefore, a brief introduction of Metrical Stress Theory is also presented, the theory on which the metrical analysis of English stress patterns is based. The other type of analysis is one which does not assume any foot structure

underlying English word stress. Another issue, presented in Section 2.1.2, is the learning mechanism which guides the acquisition of English stress patterns: one of the views examined sees stress acquisition as a process of setting the metrical parameters provided by UG, whereas the other regards it as a process of statistical extraction based on the distribution of stress patterns in the input data.

### 2.1.1. Generalizations

Chomsky and Halle (1968) observed that in a large class of English nouns, primary stress falls on the antepenultimate syllable when the penult contains a non-branching rhyme (e.g., a short vowel (CV) as in *Cá.na.da* [ka.nə.də]), and on the penultimate syllable when the penult is heavy with a branching rhyme (e.g., a long vowel (CVV) as in *a.ró.ma* [ə.roʊ.mə] or a short vowel followed by a coda consonant (CVC) as in *a.gén.da* [ə.dʒɛn.də]). The syllable structure of the penultimate syllable in these three words is presented in (2.1): the rhyme of the penultimate syllable in (2.1 a) is not branching while those in (2.1 b) and (2.1 c) are. In the diagrams,  $\sigma$  denotes syllable, R rhyme, N nucleus and C coda.

- (2.1) a. *Cá.na.da* (antepenultimate stress, non-branching penult CV)  
 b. *a.ró.ma* (penultimate stress, branching penult CVV)  
 c. *a.gén.da* (penultimate stress, branching penult CVC)



In verbs and unsuffixed adjectives, however, stress usually falls on the penultimate syllable when the final syllable is CV or CVC, e.g., *de.vé.lop*. If the final syllable contains either a long vowel (CVV(C)), e.g., *de.cáy*, or a consonant cluster (CVCC), in the coda position e.g., *ne.gléct*, stress falls on the final syllable. These examples are presented below.

- (2.2) a. *de.vé.lop* (penultimate stress, CVC ultima)  
 b. *de.cáy* (final stress, CVV(C) ultima)  
 c. *ne.gléct* (final stress, CVCC ultima)



In nouns, stress mostly falls on the antepenultimate syllable or the penultimate syllable, while in verbs and unsuffixed adjectives, stress is displaced one syllable towards the end of the word—that is, either on the penultimate syllable or on the final syllable. The occurrence of penultimate stress instead of antepenultimate stress in nouns, and final stress instead of penultimate stress in verbs and unsuffixed adjectives, is sometimes termed rightward stress shift. This rightward stress shift, i.e., from the antepenult to the penult in nouns, and from the penult to the ultima in verbs and unsuffixed adjectives, occurs under similar but slightly different conditions. Specifically, CVC causes stress shift from the antepenultimate syllable to the penultimate syllable in nouns (e.g., *Cá.na.da* but *a.gén.da*) but does not cause stress



shift from the penultimate syllable to the final syllable in verbs or unsuffixed adjectives (e.g., *de.vé.lop* rather than *de.ve.lóp*).

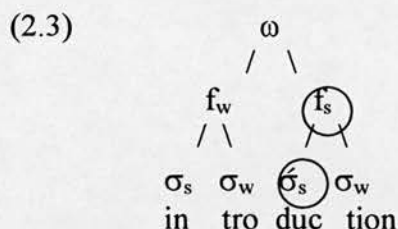
In addition to the stress patterns presented above, English also contains irregular stress patterns, so named because they do not conform to the basic generalizations. For example, some words have a CV penult but have penultimate stress rather than antepenultimate stress (e.g., *di.lé.mma*); in addition, some words have a CVC penult but are assigned antepenultimate stress (e.g., *ché.mis.try*).

This generalization for the regularities of English stress is further accounted for under the framework of the current linguistic theory of metrical phonology. The six key parameters of this framework are now briefly introduced and their settings in English are then presented.

#### 2.1.1.1. Metrical Analysis

Since Liberman and Prince's (1977) paper, stress has been analyzed as the product of metrical constituents such as feet and prosodic words. Feet consist of syllables which differ in prominence. In a pair of nodes in a foot, the prominent one is labelled as strong (i.e.,  $\sigma_s$ ) and the other one is labelled weak ( $\sigma_w$ ), and the strong node is defined as the head of foot. Feet are then constructed into prosodic words. One of the feet in a prosodic word is defined as the head of the prosodic word. The syllable that receives primary stress is the strong node in the head foot of the prosodic word. The following example in (2.3) is the hierarchical metrical structure of a phonological word ( $\omega$ ) consisting of feet ( $f$ ) and syllables ( $\sigma$ ). The subscripts  $s$  and  $w$  refer to 'strong' and 'weak' respectively. Strong syllables indicate syllables that are assigned stress; weak syllables are assigned secondary stress or none. Here, the penultimate

syllable in the word *introduction* receives primary stress as it is the head of the foot, and the foot is also the head of the phonological word, as circled.<sup>1</sup>

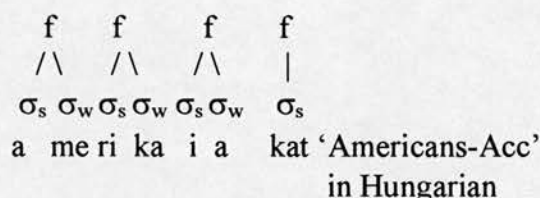
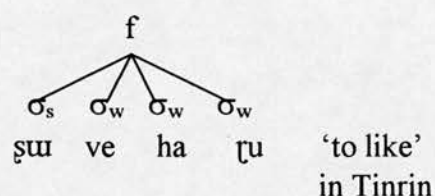


As work in metrical stress theory progressed and was extended to the analysis of many languages, the conception of stress assignment became embedded in a *parametric* view of metrical structure (e.g., Booij, 1983; Dresher & Kaye, 1990; Halle & Vergnaud, 1987b; Hayes, 1981), taking a lead from Chomskyan syntax. Under the framework of principles and parameters, the stress systems of the world's languages can be analyzed as all following the same principles, and the variations between languages can be uniformly understood in terms of different parameter settings. Metrical principles stipulate that metrical constituents are structured hierarchically, i.e., words consist of feet and feet consist of syllables. It should be emphasized that in a language metrical constituents are consistent structurally, e.g., all feet are strong on the left or on the right (e.g., English feet are strong on the left uniformly, as shown below). There is no language which has both the possibilities. In addition to the invariant principle that stipulates stress is assigned to metrical

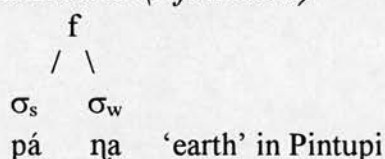
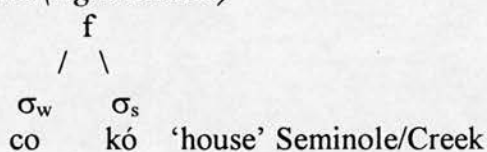
<sup>1</sup> While many analyses use trees to represent the metrical structures underlying stress (e.g., Hayes, 1981), others employ metrical grids (e.g., Prince, 1983; Selkirk, 1984) or a combination of both (e.g., Halle & Vergnaud, 1987a, 1987b; Hayes, 1984; Liberman, 1975; Liberman & Prince, 1977). The distinction between tree vs. grid representation is not an issue in the present study. We use the tree representation throughout this thesis in order to facilitate the subsequent discussion of Dresher and Kaye's (1990) parameter-setting learning model, which is widely adopted in the literature of both L1 and L2 stress acquisition and which assumes a tree-only representation.

constituents, there are some parameterized principles in this theory such as the Weight-to-Stress Principle (Prince, 1990) – syllables which contain a long vowel or a coda are heavy and must be stressed. Quantity-sensitive stress systems generally follow this principle. This principle is encoded in two metrical parameters, Quantity-sensitivity and Quantity-sensitive-to, as discussed below. Metrical parameters explain how languages can differ from each other in the organization of metrical constituents (i.e., from syllables to feet, and from feet to words) by means of binary parameter-settings. Metrical phonology theory not only formalizes the stress patterns in a language but also captures how stress languages can differ from each other in limited ways, so it benefits our understanding of different stress systems by accounting for the differences both within a given language and across languages under the same framework. Dresher and Kaye (1990) have proposed a set of metrical parameters which govern the construction of metrical constituents and the assignment of stress (see also Hayes, 1981). Some of the key metrical parameters that are relevant to our study include Foot Size, Foot Headedness, Directionality of Foot Construction, Word Headedness, Quantity-sensitivity and Extrametricality. These are now considered in turn.

The first of these is the parameter Foot Size. Feet can either be binary or unbounded. A binary foot contains two positions while unbounded feet are not subject to any restrictions on size. In the binary system, the distance between two stressed syllables is restricted to a limited distance. On the other hand, the unbounded system does not have such a restriction. Example (2.4) shows two of the structural configurations of stress systems. Hungarian is an example of (2.4 a), and Tinrin is an example of (2.4 b) (Hayes, 1995: 296-297).

(2.4) a. *binary system*b. *unbounded system*

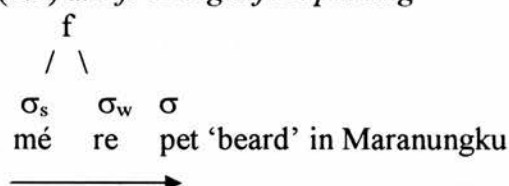
A second parameter is Foot Headedness. Generally speaking, there are two types of feet, corresponding roughly to the classical trochee ( $\sigma\sigma$ ) and classical iamb ( $\sigma\acute{\sigma}$ ). In current literature these are often referred to as “left-headed feet” and “right-headed feet” respectively. The head of the foot in Pintupi is on the left, as shown in (2.5 a) whereas heads in Seminole/Creek are on the right, as shown in (2.5 b) (examples from Haas (1977) and Hansen & Hansen (1969)). Stress falls on the strong syllable in these languages.

(2.5) a. *Trochee (left-headed)*b. *Iamb (right-headed)*

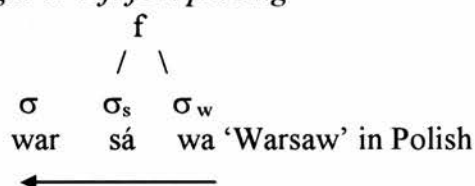
Thirdly, in words consisting of more than three syllables, languages may differ in terms of the directionality of foot construction, which goes either from left to right or from right to left. In two languages that are the same in terms of foot headedness (e.g., left-headed) but which differ in directionality, stress will be realized differently. In trisyllabic words, for example, stress will fall on the antepenultimate syllable in a language with left-to-right foot construction but on the penultimate syllable in a language with right-to-left foot construction. Maranungku feet are constructed from left to right and primary stress falls on the initial (or

antepenultimate) syllable, whereas Polish feet are constructed from right to left and so primary stress falls on the penultimate syllable. Examples (2.6 a) and (2.6 b) are taken from Tryon (1970) and Hayes and Puppel (1985) respectively, and are also cited in Hayes (1995).<sup>2</sup>

(2.6) a. *left-to-right foot parsing*

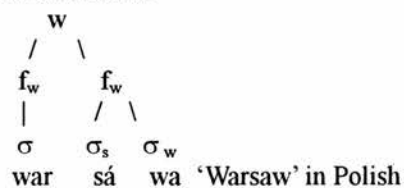
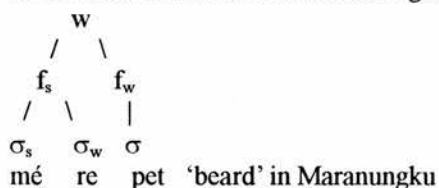


b. *right-to-left foot parsing*



Fourthly, in words with more than one foot, the placement of primary stress is determined at a higher prosodic level, i.e., the phonological word ( $\omega$ ). The head of a foot that is also the head of a word receives primary stress. There are two setting values for word headedness, i.e., either on the left or on the right. Maranungku is a language which has word headedness on the left, and primary stress falls on the initial syllable. For example, a word with six syllables is first constructed into three trochaic feet, as in (wele)(pene)(manta) '(kind of duck)', where the strong syllables of the feet are underlined in order not to be confused with primary stress. Metrical principles stipulate that feet are further constructed into words. In Dresher & Kaye's model, the construction of the word tree is unbounded; in other words, either the leftmost or the rightmost foot serves as the head of word. For instance, the setting of

<sup>2</sup> The remaining syllable forms a 'degenerate foot' by itself, and is further organized into a prosodic word with another foot at the next higher level as shown below.





this parameter in Maranungku is strong on the left, so the strong syllable in the leftmost foot receives primary stress, e.g., (wéle)(pene)(manta). On the other hand, Warao has its word headedness on the right, and its primary stress falls on the penultimate syllable. Warao is therefore a kind of mirror image of Maranungku, e.g., yi (wa ra)(ná e) 'he finished it'. These examples are taken from Hayes (1981) (see also Jensen, 1993: 82-85).

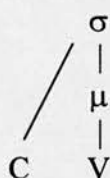
These four parameters describe the basic operation of foot constructions in stress languages. There are, however, two other parameters which play a crucial role. One of these is Quantity-sensitivity, which indicates that foot construction can be either quantity-sensitive or quantity-insensitive. In quantity-sensitive stress languages, foot construction is sensitive to syllable weight, whereas in quantity-insensitive stress language, all syllables are treated equally in foot construction. In order to understand the notion of syllable weight, we provide a brief discussion of Moraic Theory in the following paragraphs.

Since some phonological processes (e.g., stress assignment and tone association) do not treat all syllables equally, a level of prosodic constituents is postulated below the level of the syllable, namely, the level of the mora (Hayes, 1989; Hyman, 1985; Itô, 1989; McCarthy & Prince, 1986; van der Hulst, 1984; Zec, 1988, among others). One of the roles the mora plays is to specify the weight unit of syllables. Syllables can therefore be divided into two classes according to the number of moras dominated by the syllable. A syllable with one mora is defined as light whereas a syllable with two or more moras is heavy. Some languages, such as Hindi, are said to exhibit a three-way distinction of syllable weight, i.e., light (CV), heavy (CVV) and superheavy (CVVC) (e.g., Broselow, Chen, & Huffman, 1997). Onset

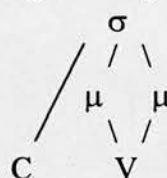
consonants are weightless universally.<sup>3</sup> Take vowels as an example. In many phonological systems, long vowels are treated differently from short vowels. This difference is captured by the mora projection from these two types of vowels, e.g., in quantity-sensitive systems, syllables with a long vowel (CVV) are more likely to be stressed compared to those with a short vowel (CV). To illustrate, a short vowel projects a single mora so it is light whereas a long vowel projects two moras so it is regarded as heavy, as shown in (2.7), where the symbol  $\mu$  refers to mora.

(2.7) *Weight of vowels*

a. short vowel (light, CV)



b. long vowel (heavy, CVV)



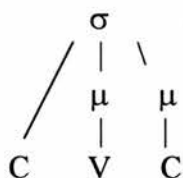
In addition to vowels, coda consonants can also affect syllable weight in some languages. Languages such as Latin treat syllables with a coda consonant differently from those without coda consonants when the vowel of a syllable is short. Specifically, CVC is heavy in Latin while CV is not. In quantity-sensitive systems like Latin and English, stress assignment is sensitive to the weight contributed by the coda consonant (i.e., CVC is heavy and tends to be stressed while CV is light and tends not to be stressed). This prominence of CVC in Latin is captured in the notion of Weight-by-Position (Hayes, 1994), which refers to the assignment of a mora to a coda consonant, as shown in (2.8a). On the other hand, languages like Yupik do not

<sup>3</sup> Rialland (1993) points out there are a few exceptions to this generalization.

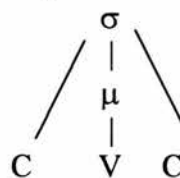
distinguish CVC from CV, indicating that Weight-by-Position plays no role in the language, as shown in (2.8 b).

(2.8) *Weight of coda consonants*

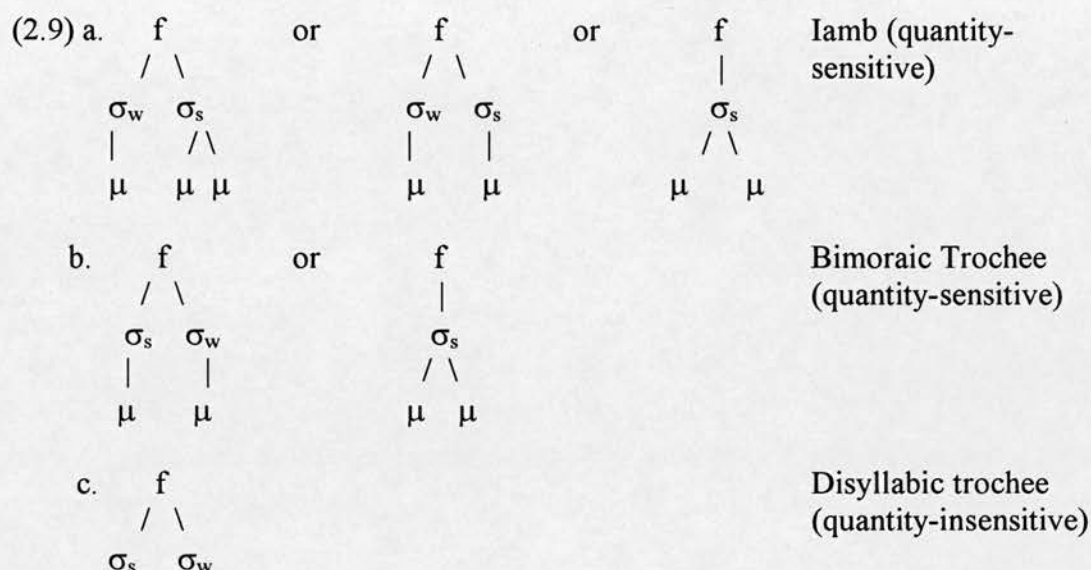
a. weight-contributing coda (heavy CVC)



b. weightless coda (light CVC)



Moraic theory has been used for the typological analysis of foot construction. Hayes (1987, 1995) identifies three possible foot types cross-linguistically based on the observation of the durational asymmetry between iambic and trochaic feet (i.e., trochaic feet ( $\sigma\sigma$ ) exhibit no durational contrast between stressed and unstressed syllables while in iambic feet ( $\sigma\acute{\sigma}$ ) the stressed syllable is longer in duration than the unstressed syllable). Iambs can be either disyllabic or bimoraic, as in (2.9 a). Moraic trochees are always bimoraic as in (2.9 b). Syllabic trochees are disyllabic regardless of the internal moraic structure of the syllable, as in (2.9 c).



This typological difference indicates that trochaic feet may be sensitive or insensitive to syllable weight. In a quantity-sensitive system, i.e., one with iambs or bimoraic trochees, heavy syllables cannot be parsed in the weak position of the foot. However, in a quantity-insensitive system, i.e., syllabic trochees, syllables are parsed into feet regardless of syllable weight. We will see that English stress assignment is sensitive to syllable weight.

Let us move back to our discussion of stress assignment. Under the framework of metrical stress theory, stress is assumed to be the product of metrical feet. And it is found that some languages treat heavy syllables differently from light syllables in terms of stress assignment, while other languages treat the two types of syllables the same. The difference between these two stress systems can therefore be captured in terms of quantity-sensitivity. It has been proposed that the Weight-to-Stress Principle (WSP) (Prince, 1990) illustrates this difference. This principle (shown in (2.10)) captures the fact that heavy syllables which receive stress in the quantity-sensitive system respect the WSP and heavy syllables which do not receive stress violate it.

(2.10) *Weight-to-Stress Principle (WSP)* (Prince, 1990)

Heavy syllables must be stressed.

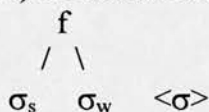
The notion of syllable weight and the WSP are central to two parameters: (i) Quantity-sensitivity [QS/QI], where QS is quantity-sensitive and QI is quantity-insensitive, and (ii) Quantity-sensitive-to [Nucleus/Rhyme]. If stress assignment is sensitive to syllable weight, the setting of Quantity-sensitivity is [QS]; otherwise it is [QI]. If it is set to QS, languages with an effect of Weight-to-Position have the other parameter set as Quantity-sensitive to [Rhyme], in which case both CVV and CVC are stressed. On the other hand, in languages with the setting [Nucleus], only CVV is stressed, not CVC.

The final parameter for basic foot formation to be mentioned here is Extrametricality. The notion of extrametricality was originally motivated by the observation that in languages such as English, Spanish, Estonian, and some dialects of Arabic, CVC syllables are heavy, except word-finally, where they are regarded as light (see Hayes (1995) and references therein). The weight distinction between word-final CVC and non-word-final CVC is explained by the mechanism of extrametricality: the word-final consonant is skipped in prosodification. Some languages such as Latin even allow the whole final syllable to be extrametrical in foot formation. Extrametricality is parameterized because some languages allow it while others do not. Suppose, for example, two languages are identical in terms of the settings of other parameters, e.g., left-headedness of feet, right-to-left parsing, but with a difference in the setting of extrametricality. The language with an extrametrical syllable at the right edge will have stress on the antepenultimate syllable, while the other, which does not allow an extrametrical syllable, will have

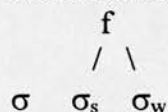


stress on the penultimate syllable. Example (2.11) shows the difference between two hypothesized structures, in which the extrametrical syllable is put inside angled brackets, “<>”.

(2.11) a. Extrametricality [Yes]



b. Extrametricality [No]



Under the framework of Metrical Stress Theory, the general patterns of English stress provided in Section 2.1.1 are interpreted in terms of metrical parameters, as shown in (2.12) (e.g., Hammond, 1999; Jensen, 1993). Under this analysis, English has left-headed quantity-sensitive binary feet, which parse syllables in a word from right to left taking extrametricality into consideration. Coda consonants can contribute to syllable weight, so it is QS-to-Rhyme. At the word level, the rightmost foot is assigned primary stress.

(2.12) *The parameter settings of English stress*

Parameter	Setting
Foot size	binary
Foot headedness	Left
Directionality of foot construction	From right to left
Word headedness	Right
Quantity-sensitivity	Yes
Quantity-sensitive to	Rhyme
Extrametricality	Yes

One issue which requires a little further explanation is the specific use of extrametricality in English. Generally speaking, English allows extrametricality; its

setting is [Yes]. In addition, English has two specific extrametricality rules, Noun Extrametricality and Consonant Extrametricality (Hayes, 1982; Jensen, 1993).

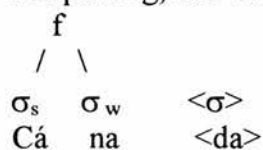
(2.13) *Extrametricality rules in English*

- a. Noun Extrametricality
- b. Consonant Extrametricality (for verbs and unsuffixed adjectives)

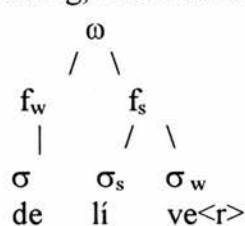
Noun extrametricality dictates that the majority of trisyllabic nouns have stress on the antepenultimate syllable. This is due to the fact that, in nouns, the whole final syllable is ignored in right-to-left foot parsing. On the other hand, the majority of verbs and unsuffixed adjectives have stress on the penultimate syllable because in these two classes of words only the final consonant is extrametrical. Consonant extrametricality captures the fact that CVC is treated as being light in the word-final position. Example (2.14) exhibits the stress contrast between nouns and verbs/unsuffixed adjectives.

(2.14) *Stress assignment in English trisyllabic nouns and verbs/unsuffixed adjectives*

- a. Noun extrametricality, right-to-left parsing, left-headed



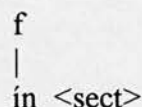
- b. Consonant extrametricality, right-to-left parsing, left-headed



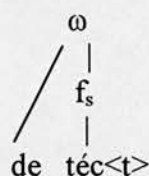
The two extrametrical rules also explain the noun-verb stress contrast in disyllabic words which end in a CVCC final syllable, as shown in (2.15).

(2.15) *Stress contrasts in English disyllabic nouns and verbs ending in CVCC*

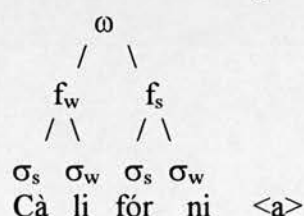
a. Noun extrametricality, right-to-left parsing, left-headed



b. Consonant extrametricality, right-to-left parsing, left-headed



In longer words, the effect of word headedness can be observed. Take the word *California* in (2.16) as an example. Foot formation ignores the final syllable *-a* due to noun extrametricality. Next, from right to left the penultimate and antepenultimate syllables form one trochaic foot *fórni*, and the other two syllables, *Cáli*, form another foot. Finally, because the word is strong on the right, the head of the right foot (i.e., *fór*) receives primary stress, and the head of the other foot (i.e., *Cà*) receives secondary stress.<sup>4</sup>

(2.16) *English word headedness on Right*

The rightward stress shift, i.e., from the antepenultimate syllable to the penultimate syllable in nouns, and from the penultimate syllable to the ultimate syllable in verbs/unsuffixed adjectives, is regarded as the effect of quantity-sensitivity. As

<sup>4</sup> The word *California* is pronounced with 4 syllables in many varieties of English, with *nia* as [njə]. However, the main point of this example is to help demonstrate the headedness of the word is on the right along with the application of Noun Extrametricality.



consonant extrametricality, stress shift occurs only when the ultimate syllable is CVCC (e.g., *de.téct*) and not CVC (e.g., *cán.cél*) because the former is heavy after extrametricality applies (i.e., CVC<C>) while the latter is light (i.e., CV<C>).

To sum up this section, the generalization of English stress in Section 2.1.1 is provided with a theoretical analysis in terms of parameterized metrical principles under the framework of metrical stress theory. Stress in English mono-morphemic words can be characterized as having the form of binary feet, which are structurally left-headed, parsed from right-to-left, quantity-sensitive to rhyme; they show the effect of extrametricality rules which are sensitive to parts of speech, and their word trees are strong on the right. Finally, under the metrical analysis, irregular stress patterns are treated as exceptional cases and stored separately in the lexicon; they are not analyzed in terms of parameter setting.

It is worth pointing out, however, that the analysis presented above has not been accepted by all of the researchers working in English stress theory. For instance, it is not difficult to find words whose stress patterns do not fit this generalization and metrical analysis. One example is the word *accès*: the primary stress does not fall on the final syllable even though it is heavy with a coda consonant; instead, primary stress falls on the initial syllable and the final syllable is assigned secondary stress. According to Halle & Vergnaud (1987b), this exceptional stress pattern is derived from the application of rhythmic rules (e.g., Stress Retraction). In addition, there is much disagreement as to which stress pattern should be treated as regular and which cases are exceptions. For example, the word *police* is analyzed as having a regular stress pattern in Halle & Vergnaud (1987b) but treated as exceptional in Halle (1998). Even though the lack of agreement on English stress theory potentially poses a



problem for the metrical analysis we have presented, this study has minimized the effect of the theoretical disagreement by looking at the assignment of primary stress in mono-morphemic words with two or three syllables, since the general analysis of this type of words is largely undisputed.

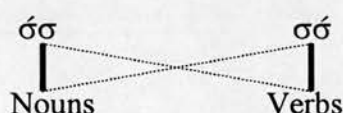
#### **2.1.1.2. Non-metrical Analysis**

Although English stress patterns can be analyzed in terms of metrical parameters, this is not the only way they can be treated. Many psychologists do not refer to, or do not assume, a metrical analysis of this sort when they study stress learning, whether in native-speakers or non-native speakers. For example, while metrical analyses assume that English feet are uniformly trochaic (i.e., left-headed), the non-metrical analysis does not have this kind of assumption. Crucially, when non-metrical analyses use the terms 'trochaic' or 'iambic', they are usually referring to the stress pattern of disyllabic words, not feet, and the distribution of these patterns has a close correspondence with lexical classes such as nouns and verbs (e.g., Kelly, 1992; Kelly and Bock, 1988; Sherman, 1975). In this section we use the term "non-metrical" in order to draw a contrast with the previous analysis which was based on metrical parameters (the "metrical" analysis). More precisely, the non-metrical analysis presented here refers to the distribution of English stress patterns and does not involve the construction of metrical constituents through the application of metrical parameters. The non-metrical analysis differs from the metrical analysis mainly in that a stress pattern is taken to be an unanalyzed stress chunk which is isomorphic to a word and consists of one strong syllable and one or more weak syllables. Its occurrence is not necessarily involved in the operation of abstract



phonological principles and parameters of the type adopted by the metrical approach. Instead, the occurrence of two stress patterns (i.e.,  $\acute{\sigma}\sigma$  and  $\sigma\acute{\sigma}$ ) in disyllabic English words can be reliably predicted from two lexical classes (i.e., nouns and verbs) simply from the distribution of stress patterns in English. In order to compare the non-metrical analysis with the metrical analysis above, we schematize the non-metrical mapping of the surface stress patterns onto lexical classes in (2.19), where thick lines mean that the correlation between surface stress patterns and lexical classes is strong, and thin lines mean the correlation is weak. It should be emphasized here that the non-metrical analysis does not distinguish so-called “regular” and “exceptional” stress patterns. In other words, both the patterns are part of the distribution: “regular” cases simply occur more frequently in the input compared to “irregular” cases. Therefore, the learning of stress patterns is gradient rather than the binary, all or nothing, distinction in the parameter setting account.

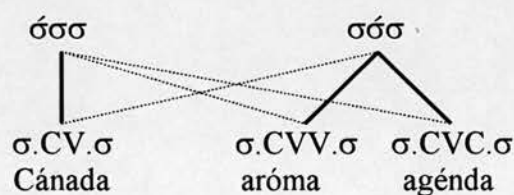
(2.19)



This distributional analysis for the stress patterns of disyllabic words can be extended further, so that the stress patterns in English trisyllabic nouns can be seen as a mapping between surface stress patterns and types of syllable structure. Notions such as Noun Extrametricality and metrical feet can be abandoned in this analysis. For example, the two main patterns seen in English trisyllabic nouns are

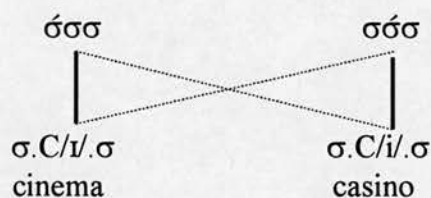
antepenultimate stress (i.e.,  $\acute{\sigma}\sigma\sigma$ ) and penultimate stress ( $\sigma\acute{\sigma}\sigma$ ). Antepenultimate stress maps onto words with a CV penult, whereas penultimate stress maps onto words with a CVV or CVC penult, if the distribution of the input data licenses this mapping. It is worth re-emphasising that since the main difference between the non-metrical analysis and the metrical analysis is that the non-metrical analysis does not assume metrical feet, questions such as whether or not the final syllable of trisyllabic nouns is extrametrical, and whether  $\acute{\sigma}\sigma\sigma$  is parsed into a disyllabic trochee but  $\sigma\acute{\sigma}\sigma$  is parsed into a bimoraic trochee, are not of concern in this analysis. This is schematized in (2.20).

(2.20)



This stress mapping in (2.20) does of course rely on some sort of phonological structure (e.g., syllable type). However, the surface stress patterns may also map with other things, such as vowel types, which may distinguish the different stress patterns depending on the depth of an analysis. For instance, an alternative analysis to (2.20) would be one like (2.21), in which the unanalyzed stress patterns map with types of vowels, i.e., the pattern  $\sigma\acute{\sigma}\sigma$  maps English nouns whose penult contains a tense vowel (e.g., /i/) whereas the pattern  $\acute{\sigma}\sigma\sigma$  maps English nouns whose penultimate contains a lax vowel (e.g., /ɪ/)

(2.21)



This section has presented how English stress can be analysed in a way that does not make the assumption that syllables must be organized into feet, and feet into words, via the operation of the metrical parameters in UG. The two types of analysis have been presented in this contrastive way since these concepts are closely related to the question of what kind of learning mechanism can permit a stress system to be learned. In the following section, two general learning mechanisms are presented.

### 2.1.2. Learning Mechanisms

The previous section has presented the descriptive generalizations of English word stress, followed by metrical and non-metrical analyses of those generalizations. In this section, we introduce two general mechanisms by which a stress system has been said to be acquired.

#### 2.1.2.1. UG-based Parameter-setting

One learning mechanism which has been proposed is parameter-setting, a UG-based acquisition theory. The central idea of parameter-setting is that a set of a priori metrical parameters with binary choices are provided by UG from the very

outset of learners' stress acquisition. This is shown in (2.22).<sup>5</sup> We use Dresher and Kaye's (1990) model here to illustrate parameter-setting since this model has been successfully used with machine learners, and more importantly their results have been applied to both child L1 stress acquisition and adult L2 stress acquisition (e.g., Fikkert, 1994; Archibald, 1993b; Pater, 1997). In this model, learning a stress system is regarded as a process of constructing metrical feet by setting the innate parameters toward their actual values in the target language.

(2.22) *Dresher and Kaye's model* (1990: 142-143)

Parameters [Settings]	Default
P1: The word tree is strong on the [Left/Right].	Binary
P2: Feet are [Binary/unbounded].	
P3: Feet are built from [Left/Right].	QI
P4: Feet are strong on the [Left/Right].	
P5: Feet are Quantity sensitive [QS/QI].	
P6: Feet are QS to the [Rhyme/Nucleus].	
P7: A strong branch of a foot must itself branch [Yes/No]	
P8A: There is an extrametrical syllable [No/Yes].	
P8: It is extrametrical on the [Left/Right].	
P9: A weak foot is defooted in clash [Yes/No]. <sup>6</sup>	
P10: Feet are noniterative [No/Yes].	

One important question which arises then is how these parameters are set to the target-like value. If each of the eleven parameters was set independently, for example, 2048 possible stress systems would be generated (there are 11 parameters in total and each of them has two possible values). If this was the case, the learning task would be incredibly huge and some impossible stress systems could be

<sup>5</sup> Other studies which assume the innateness of metrical parameters or constraints include Tesar and Smolensky (1998, 2000) and Apoussidou and Boersma (2003, 2004). These models differ from each other in terms of the learning algorithms which they posit, which deal with problems such as the order of setting parameters and the solution of error occurrences, but they share the fundamental idea that learners are endowed with a set of abstract metrical parameters from the outset of stress acquisition.

<sup>6</sup> This parameter refers to an operation of defooting in the case of a clash which results in destressing.



generated. Dresher and Kaye therefore argue that the acquisition of stress via parameter-setting is constrained.

Firstly, Dresher and Kaye assume that some parameters have default settings in the initial stage. Based on the assumption that learners only have access to positive evidence, some metrical parameters are argued to have default settings. As mentioned in Chapter 1, if something can be switched from X to Y with positive evidence, but not the other way around, then we need to take X to be the default. Building on this logic, Dresher and Kaye propose that the default setting of Quantity-Sensitivity is QI (quantity-insensitive). For instance, in the trochaic system, when stress is assigned to disyllabic words, the quantity-insensitive system (i.e., syllabic trochaic) allows only fixed stress patterns regardless of syllable weight (e.g.,  $'\sigma_u\sigma_u$ ,  $'\sigma_{uu}\sigma_u$  and  $'\sigma_u\sigma_{uu}$ ). On the other hand, the quantity-sensitive system (i.e., moraic trochee) will have movable stress patterns in the presence of heavy syllables (e.g.,  $'\sigma_u\sigma_u$  and  $'\sigma_{uu}\sigma_u$  but  $\sigma_u'\sigma_{uu}$ ). The default setting of this parameter is argued to be QI since the movable stress patterns can lead to the setting of QS on the basis positive evidence. In addition, Dresher and Kay also assume that not all parameters are set independently. Rather, the settings of some parameters are dependent on other parameters. For instance, the setting of P2 (Feet Size) must be [Binary] as long as P5 (Feet are Quantity Sensitive) is [QI]. That is, the combination of P5 [QI] and the other value [Unbounded] of P2 Feet Size is an impossible stress system since [Unbounded] is vacuous when P5 is QI.

There are, however, some parameters whose setting cannot be determined in the initial stage (e.g., Foot Headedness [Left/Right], Directionality of Foot Construction [Left-to-Right/Right-to-Left] and Word Headedness [Left/Right]).

These parameters have to be set after learners are exposed to input data. For instance, the appropriate cue for setting of the Foot Headedness [Left] and Foot Construction [Left-to-Right] ( $\rightarrow$ ) is when a light syllable (L) following any syllable is always unstressed (e.g.,  $(\sigma Lw)\rightarrow$ ), where L means “light syllable” and w “unstressed”. This is because if left-headed feet are constructed from left to right, then a light syllable must become the weak right sister of an immediately preceding syllable. Therefore, the presence of a stressed light syllable in that position would provide a learner with positive evidence that this is not the correct setting.

Assuming that learning is deterministic and that no backtracking or resetting is allowed, Dresher (1999) further argues that parameters need to be set following a specific learning path which specifies the order in which parameters have to be fixed, as shown in (2.23). The proposed ordering allows the grammar to grow from simple to complex and from concrete to more abstract (see Dresher (1999: 41)). Under this path, every learner starts out with the status of P5 [QI] and P2 [Binary].

(2.23) *Dresher's (1999) learning path*

QS [QS/QI]	P5
Extrametricity	P7
Foot Size [ <u>Binary</u> /Unbounded]	P2
Main stress	P1
Foot Headedness	P4
Directionality	P3

Since the fixing of parameters relies on the cues provided by input data, the robustness of the cues provided by the input data becomes crucial for learners if they are to set the values of parameters correctly. Ideally, the observed stress patterns of the language are exactly those that follow from the parameter-setting of its stress

system. However, languages often have idiosyncratic properties or exceptions. In order to ensure that parameters are not set on the basis of exceptional data, Dresher and Kaye propose a solution in which each parameter is associated with a counter. When the learner encounters a cue for the marked value of a certain parameter, this does not permanently trigger a change in the parameter setting; rather, the counter associated with the parameter is activated until a certain saturation point is reached. At this point the parameter associated with the counter is set. So, as long as exceptions are not too frequent, they do not affect the setting of parameters. Instead, exceptional cases are stored outside the core grammar and do not affect parameter-setting.

Under this framework, non-target-like setting may sometimes occur. For instance, mis-setting may result from learners' wrong observation of input data. It is also possible that cues which trigger some parameters are insufficient, e.g., longer words are needed to set the parameters like Directionality of Foot Construction and Word Headedness (Dresher & Kaye, 1990). Nevertheless, the patterns attested should still fall within the range of natural languages since the parameter values provided for each parameter are limited and are designated for the possible stress patterns of languages.

Although Dresher and Kaye's parameter-setting model has been applied to L1 stress acquisition (e.g., Fikkert, 1994), it is not so clear whether it can also be applied to L2 stress acquisition, or, if so, what kind of empirical data can or cannot be taken as supporting evidence that L2 learners acquire stress acquisition via parameter-setting. Conservatively speaking, since it is argued that infrequent and exceptional cases do not trigger parameter-setting, the grammar constructed is

expected to be structurally consistent. For instance, if the parameters Quantity-sensitivity and Quantity-sensitivity-to are set to the values [QS] and [Nucleus] respectively, it is expected that long or tense vowels as a class would be preferred to be stress-bearing in contrast with short or lax vowels, as a class. This study will test whether or not L1 Chinese speakers assign stress based on the type of syllable structure. In addition, the developmental patterns which reflect the unmarked structure and settings have often been regarded as evidence for learners' access to UG; therefore, they might be taken as evidence for UG-based acquisition. However, Zamuner (2003) and Zamuner, Gerken, and Hammond (2005) argue that cross-linguistically unmarked structures are usually the most frequent patterns of the ambient language to which learners are exposed (e.g., CV is regarded as unmarked but it may be also the most frequent syllable structure in a language). In other words, the preference for the unmarked structure can be equally well accounted for both from the point of view of UG-based parameter-setting and from the frequency effect of the ambient input. Thus, the support for UG-based models like parameter-setting which has been claimed on the basis of learners' preference for the unmarked needs more detailed examination.

#### **2.1.2.2. Input-based Statistical Learning**

Input-based statistical learning accounts make no assumption of an a priori set of metrical principles and parameters, and do not see stress assignment as mediated by metrical constituents such as feet. Instead, the development of L2 stress patterns is seen as a process of statistical extraction based on the distribution of stress patterns in the input data. Davis and Kelly (1997), for instance, argue that the noun-



verb stress contrast in English disyllabic words can be learned by means of statistical learning, in which learners generalize across the instances of the ambient language and use distributional information associated with different stress patterns. Therefore, the acquisition of the English noun-verb stress contrast may occur outside the core grammar and without requiring any domain-specific phonological operation. Although Davis and Kelly do not specify the meaning of ‘phonological operation’, we speculate that it refers to something like rules or parameter setting since they are interested in seeing how stress is learned under the situation in which UG is assumed to be unavailable. We will discuss this study further in Section 2.2.1.3 below.

It is also important to consider what kind of evidence would indicate that stress patterns are learned via statistical extraction. Firstly, since all the stress patterns in a language, both “regular” and “exceptional”, are regarded as part of the distribution, knowledge constructed on this basis would be gradient rather than categorical. Ideally, the knowledge constructed this way would also have a close match with the stress patterns of the ambient language. Secondly, while acquisition via parameter setting is expected to be structurally consistent, e.g., CVC syllables as a class are stress-attracting but CV as a class are not, statistical learning is not necessarily so. The generalizations are less constrained in the statistical learning model, so learners may use cues such as lexical classes as well as syllable structure, (as presented in examples (2.19) and (2.20)) or even the cues provided by individual vowels (see (2.21)) to help them generalize stress patterns. In short, any patterns which show that learners track the statistical distribution of the input data operating over some sort of linguistic or non-linguistic representations constitute evidence consistent with statistical learning.



When the two accounts are compared, the type of information which is accounted for by the two learning mechanisms is often quite different. As we have seen, parameter-setting centres on formal accounts of how learners construct abstract metrical constituents via fixing the whole set of metrical parameters, e.g., how learners determine the setting of innate parameters via a logically possible learning path. The input-based statistical learning account focuses instead on how learners learn a language by showing their sensitivity to the distribution of linguistic patterns in the ambient language. These differences make the parameter-setting model and the statistical learning model difficult to compare. In order to allow for a reasonable comparison between the two theories, the current study explores L2 word stress acquisition only. This is also an area which is in dispute in the existing literature. In studies of L2 stress acquisition, some studies have argued that L2 learners acquire a new stress system via parameter-resetting, especially when the learners' L1 is also a stress language (e.g., Archibald, 1993b). Other patterns that are not explainable from L1 transfer but are found to follow the principles of metrical phonology are considered to be evidence for the mis-setting of these abstract parameters (Pater, 1997). Nevertheless, other studies provide other alternative explanations in terms of the statistical information in the input data (e.g., Davis & Kelly, 1997). We will provide a more detailed discussion below about evidence to support these different claims.

## **2.2. Review of L2 Word Stress Acquisition**

This section reviews the literature on L2 word stress acquisition in order to highlight the findings which are most relevant to the main concern of this study, that is, the

extent to which L2 stress acquisition can be characterized in terms of learners' L1 transfer and metrical universals. This is followed by a discussion of the learning mechanism which may guide the acquisition of L2 word stress. Findings from previous L2 stress studies using native speakers of stress languages and native speakers of non-stress languages (i.e., lexical tone languages and lexical pitch accent languages) have shown a great deal of variation between the two groups; therefore, our review treats the discussion of L2 stress acquisition in these two groups of learners separately.

## **2.2.1. English Word Stress Acquisition by Native Speakers of Stress Languages**

### **2.2.1.1. Evidence for L1 Transfer**

L1 transfer is widely reported in L2 stress assignment. The transfer may come from L1 stress patterns directly or from L1 phonotactics. We will first look at the influence from L1 stress patterns, followed by the transfer from L1 phonotactics.

Our first case comes from native speakers of Polish learning L2 English stress. Polish has a rather fixed word stress pattern: primary stress usually falls on the penultimate syllable regardless of syllable structure, e.g., *Warsáwa* 'Warsaw' and *kinematográfka* 'little female cinematographer'. Antepenultimate stress does sometimes occur, but only in very limited cases, namely, in words with the monosyllabic suffix *-a*, e.g., *gramátyk-a* 'grammar' vs. *gramatyk-ámi* 'university'. Based on a read-aloud task and a perception task of real English words of 2 to 4 syllables both in isolation and in sentence contexts, Archibald (1993b) found that Polish learners of English made systematic errors that corresponded to the stress patterns of their L1. The most common type of error made by Polish learners of

English was the assignment of penultimate stress to trisyllabic nouns, as in (2.24 a), and the assignment of penultimate stress to disyllabic verbs containing a final heavy syllable, as in (2.24 b). Another common type of error was the assignment of antepenultimate stress to trisyllabic nouns whose penult is heavy and whose ultima ends in *-a*, as in (2.24 c).

(2.24) *Errors made by Polish learners of English*

- a. cábinet → cabínét; vénison → veníson; jávelin → javélin
- b. maintáin → máintain; áchieve → áchieve
- c. aróma → ároma

These error patterns are further interpreted by Archibald as the transfer of Polish parameter settings. Under the framework of metrical stress theory, Polish stress differs from English stress mainly in the setting values of two parameters, Quantity-Sensitivity and Extrametricality, as shown in (2.25).

(2.25) *Comparison of Polish and English parameter settings*

Parameters	Polish settings	English settings
Feet are [Unbounded/Binary]	Binary	Binary
Feet are built from the [Left/Right]	Right	Right
Feet are strong on the [Left/Right]	Left	Left
Feet are Quantity-sensitive [QS/QI]	<b>QI</b>	<b>QS</b>
Feet are QS to the [Rhyme/Nucleus]	N/A	Rhyme
There is an extrametrical syllable [No/Yes]	<b>No</b> <sup>7</sup>	<b>Yes</b>
There is an extrametrical syllable on the [Right/Left]	N/A	Right

According to Archibald, the tendency of the Polish subjects to assign penultimate stress to trisyllabic nouns that should have antepenultimate stress, as in (2.24 a), is due to the fact that Polish does not generally allow extrametrical syllables, i.e., there

<sup>7</sup> Although Polish has extrametricality in the limited cases of suffix *-a*, Archibald assumes that the setting of the extrametricality parameter is [No] due to the majority of words having penultimate stress.

has been a transfer of the setting of Extrametricality [No]. In addition, although English verbs with a final heavy syllable should receive final stress, as in (2.24 b), Polish subjects tended to assign penultimate stress to these words, because Polish stress is insensitive to syllable weight; i.e., this was a transfer of the setting of Quantity-sensitivity [QI]. In addition, the Polish speakers tended to assign antepenultimate stress to some English nouns ending in *-a*. While these learners did not generally make errors in assigning stress to words like *cinema*, they did more often make errors with words like *aróma*, which is usually assigned antepenultimate stress, as shown in (2.24 c). Archibald's explanation of this type of error relies on the fact that in Polish the monosyllabic suffix *-a* is skipped in stress assignment, e.g., *gramátyk-<a>* 'grammar' (Halle, 1987b). He speculates that these learners misanalysed the English words ending in *-a* as suffixed words, and therefore assigned antepenultimate stress, as in *árom-a* and *cínem-a*.

There is also evidence available from error patterns made by Hungarian learners of English. Simple Hungarian words always have primary stress in the initial syllable (see e.g., Varga, 2002 and references therein). In addition to primary stress, Hayes (1995) shows that Hungarian has rhythmical secondary stress which falls on alternating syllables after the primary stress, e.g., *'ame,rika,ia,kat* 'Americans-ACC' (the symbol " ' " before a syllable indicates primary stress and the symbol " , " indicates secondary stress). Furthermore, secondary stress in Hungarian is sensitive to syllable weight (Gráf, 2001 and references therein). That is, when there is a long vowel (symbolized by an acute accent on the top of a vowel, e.g., *á*), secondary stress is attracted from the regular alternations, e.g., *hatalmas,ságok* 'mighty ones', where the regular rhythmical secondary stress should originally fall on the



syllable *-mas-*, but is attracted to the following syllable *-sá-* because there is a long vowel *á*.<sup>8</sup> Using the same task as was used with Polish speaking learners of English, Archibald (1993b) found that Hungarian learners of English also made systematic errors which corresponded to the stress patterns of their L1. In particular, the errors made by Hungarian learners of English are systematically different from those which were made by the Polish speakers. The most typical type of errors made by the native speakers of Hungarian was in the assignment of initial primary stress, which corresponds with the fixed initial primary stress in Hungarian, as presented in (2.26).

(2.26) *Errors made by Hungarian learners of English*  
*agénda* → *ágenda*; *aróma* → *ároma*

In addition, some learners were found to make a stress shift from the initial syllable to other heavy syllables to the right. This shift occurs more frequently in syllables containing a long vowel than in syllables with coda consonants. The number of *ÁGENDA*-type errors is double that of *ÁROMA*-type errors (38 tokens for *ÁGENDA*-type errors and 16 tokens for *ÁROMA*-type errors) (Archibald, 1993b: 112).<sup>9</sup> This is consistent with the fact that Hungarian secondary stress shift occurs in syllables with a long vowel only and not in syllables with coda consonants.

Taking a metrical theoretic approach, Archibald further interprets L1 transfer in terms of parameter-setting. Specifically, Hungarian stress differs from English stress mainly in the setting values of three parameters, Directionality of foot

<sup>8</sup> In van der Pas & Zonneveld's (2004: 148) review of this study, they point out that whether secondary stress in Hungarian is sensitive to rhyme or nucleus is still a question that requires more research. For instance, Kerek (1971) suggests that Hungarian secondary stress is sensitive to rhyme, and not just to a heavy nucleus. Thus, whether Archibald's theoretical assumption about the setting [Nucleus] in Hungarian is valid or not is still an open question.

<sup>9</sup> The errors were mainly found in the perception tasks. The two types of errors in the production tasks were not significantly different.



construction, Quantity-sensitive-to and Extrametricality. This is shown in (2.27), where the differences are highlighted.

(2.27) *Comparison of Hungarian and English parameter settings*

Parameterized Principles	Hungarian settings	English settings
Feet are [Unbounded/Binary]	Binary	Binary
Feet are built from the [Left/Right]	<b>Left</b>	<b>Right</b>
Feet are strong on the [Left/Right]	Left	Left
Feet are Quantity-sensitive [QS/QI]	QS (2 <sup>nd</sup> stress)	QS
Feet are QS to the [Rhyme/Nucleus]	<b>Nucleus</b>	<b>Rhyme</b>
There is an extrametrical syllable [No/Yes]	<b>No</b>	<b>Yes</b>
There is an extrametrical syllable on the [Right/Left]	N/A	Right

According to Archibald, the error pattern in (2.26) is due to the transfer of the Hungarian setting of the directionality of foot construction (i.e. left-to-right). In addition, the pattern in which Hungarian learners of English are more sensitive to syllables with a long vowel (e.g., *aroma* /ə.róu.mə/) than those with a coda consonant (e.g., *agenda* /ə.gén.də/) is accounted for as the transfer of the setting of Parameter Quantity-sensitivity-to [Nucleus] in Hungarian.

However, differences in stress patterns are not the only source of L1 transfer in L2 stress acquisition. The transfer effects on stress assignment may come from L1 phonotactics rather than from L1 stress patterns. For instance, Archibald shows that although Spanish and English have identical settings for the metrical parameters (i.e., binary feet, right-to-left parsing, feet strong on the left, quantity-sensitive to rhyme and extrametricality on the right), Spanish learners of English still made stress errors. Most errors were in fact caused by the phonotactics of syllables in Spanish. Archibald (1993a, 1998) indicates that Spanish speakers have a tendency to assign stress to the final syllable of an English word when the syllable is closed by a

consonant (e.g., *móuntain* is pronounced as *mountáin*, and *mórpheme* as *morphéme*). This is interpreted as the transfer of a Spanish stress rule, i.e., stress the final syllable when it is closed by a consonant, e.g., *paréd* 'wall' though Archibald did not explain why the identical setting of the extrametricality parameter between two languages does not occur.<sup>10</sup>

In short, the transfer of L1 stress patterns is well attested in the literature. And some of these patterns have been further interpreted as the transfer of L1 parameter-settings.

#### 2.2.1.2. Evidence for Universals

In comparison with the amount of empirical evidence available for L1 transfer, unambiguous evidence for the possible effects of metrical parameters is hard to come by. In L2 segments and syllables, many patterns which are independent of both L1 and L2 can be accounted for in terms of their markedness according to phonological theories (see above, Section 1.1.2). To our knowledge, there is only one study which has reported evidence of a stress pattern that is independent of both learners' L1 and L2 and still a possible stress system found in other natural languages, namely, Pater (1997). But we will show that there may be other explanations for Pater's results.

Pater (1997) found that French learners of English produced patterns that cannot be attributed to either French or English. When 57 French subjects were asked to read aloud a list of English non-words with 3 or 4 syllables and with different combinations of heavy and light syllables, they showed systematic patterns of stress

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<sup>10</sup> The effect of L1 transfer of Spanish phonotactics is also reported by Mairs (1989). This study is not discussed here since it includes both mono-morphemic words and multi-morphemic words, and the evidence for the transfer of Spanish phonotactics was attested mostly in multi-morphemic words, which is not the main interest of this study.

placement. The most interesting of these was a preference for assigning initial stress to trisyllabic and quadrisyllabic words (e.g., *gá.di.ma* and *kán.den.tàla*). Since in French, primary stress typically falls on the rightmost syllable of a word, this preference for initial stress in English non-words cannot be traced to patterns of stress placement in French. However, the preference for primary stress on the initial syllable of quadrisyllabic words is not English-like either – English usually has primary stress falling on one of the three syllables at the right edge. Therefore, the stress patterns attested in French-English interlanguage are independent of both the source language and the target language. Assuming the framework of parameter-setting, Pater explained these patterns as the mis-setting of two parameters (i.e. the Directionality of Foot Construction and Word Headedness). Specifically, the Directionality of Foot Construction in English is from right to left whereas French learners set it as left to right, and the Word Headedness parameter in English is strong on the right whereas French learners set it to be strong on the left. The subjects were said to have set the parameter values in a way that is neither native-like nor target-like. Evidence for the mis-setting of left-to-right foot construction mainly came from two robust patterns, namely, the assignment of primary stress on the initial syllable of trisyllabic nouns with a light penult (e.g., *gá.di.ma*) and the assignment of secondary stress on the penultimate syllable of quadrisyllabic nouns with a light penult (e.g., *kán.den.tàla*). The pattern *gá.di.ma* can be accounted for either as right-to-left parsing with extrametricality or as left-to-right foot parsing and an unknown setting for extrametricality, as shown in (2.28).

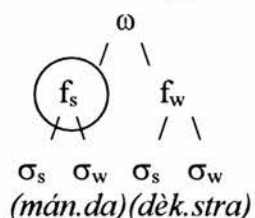
(2.28)

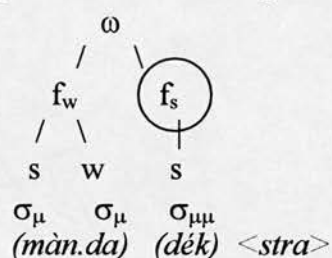
- a. *right-to-left parsing and extrametricality*      ✓      b. *left-to-right-parsing*  
 (gá.di)<ma>      (gá.di) ma
- $\xleftarrow{\hspace{1.5cm}}$ 
 $\xrightarrow{\hspace{1.5cm}}$

To clarify which analysis was more plausible for these French learners of English, Pater analysed the quadrisyllabic test words and found that primary stress was mostly assigned to the initial syllable, less often to the third (or penultimate) light syllable, e.g., (*kánden*)(*tàla*), and very rarely to the antepenultimate syllable. This suggested that the parsing was left-to-right, as shown in (2.28 b).

In addition to the mis-setting of foot parsing directionality, Pater's French subjects preferred longer words to have primary stress on the left edge and secondary stress on the right edge, which again is the opposite of the pattern preferred by English native speakers. This was interpreted as the mis-setting of the parameter Word Headedness. For instance, the French subjects tended to prefer main stress on the first syllable of quadrisyllabic words, suggesting that Word Headedness is set to be left, as Example (2.29) shows. On the other hand, English subjects tended to prefer main stress on the penultimate syllable, and word stress on the right. When re-setting the parameter values towards English, French learners of English mis-set the word headedness parameter to be strong on the left, as Example (2.30) shows.

(2.29) French learners' settings: word headedness on the **left**



(2.30) English controls' settings: word headedness on the **right**

Although the patterns shown in Examples (2.28 b) and (2.29) are neither French-like nor English-like, they are nevertheless sanctioned by the metrical parameters of UG.<sup>11</sup> The question which then arises is why French learners mis-set these parameters. As far as Word Headedness is concerned, an explanation proposed by Pater refers to the nature of the input. Although word stress is strong on the right in English, there are a number of patterns which occur in English which might indicate that it could also be strong on the left. For instance, English nouns are mostly shorter (e.g., two or three syllables long) and often have one stress occurring at the left edge. In addition, main stress sometimes shifts to the left in English (e.g., *anecdôte* rather than *anecdôte*). These facts could mislead learners into assuming that the setting of Word Headedness is on the left. Then the mis-setting of the Directionality of Foot Construction parameter to left-to-right can be attributed to the correlation between these two parameters, since when Word Headedness is set to be on the left, the unmarked setting of Foot Construction Directionality tends to be left-to-right (Hammond, 1985). So although the mis-setting of the directionality parameter does not result from these learners' L1 stress system, nevertheless, it is still a possible stress system in UG and reflects metrical universals.

<sup>11</sup> In fact, Pater suggested that similar patterns are seen in children's stress acquisition, and some studies of L1 stress acquisition (e.g., Fikkert (1994) and Hochberg (1998a, 1998b)) seem to support this claim.



However, as Pater himself also pointed out, there is little agreement on the unmarked settings of the metrical parameters, Directionality of foot construction and Word headedness. For instance, Kager (1995) finds no correlation between the settings of the two parameters in the typological survey. The lack of agreement on metrical theory leaves the explanation of markedness inconclusive. In addition, as just mentioned, Pater suggests that the factors that lead to the mis-setting of the Word headedness parameter include (i) English words are generally short and (ii) there are many conflicting instances such as the word *anecdote*, in which the primary stress falls on the left, rather than fulfilling the theoretical prediction of being on the right. Therefore, another possibility, in addition to Pater's interpretation, is that the Word headedness parameter is not properly set if one assumes that the setting of metrical parameters follows principles like those proposed by Dresher & Kaye (1990), e.g., robustness of the cues (see p. 57 of this thesis). Then an alternative explanation for these learners' preference for primary stress on the initial syllable rather than on the penultimate syllable in quadrisyllabic words would be the effect of over-generalization due to initial stress being the most common and frequent stress pattern in English regardless of the number of syllables in a word. One more remark about Pater's study is the question of whether it is possible to reset the mis-set parameters to the actual target values. This is significant in the light of the parameter-setting model proposed by Dresher and Kaye, where learners are assumed to be deterministic and allow no backtracking and re-setting of parameters. If Dresher and Kaye's assumptions are correct, it would not be possible for the French speakers to re-set the parameters. However, this is not to call Pater's analysis into question, rather simply to raise the issue, since, as indicated by Fikkert (1994), it remains an

open question requiring empirical testing whether Dresher and Kaye's model itself fits the actual process of stress acquisition in human learners.

Finally, this pattern might be a case of L1 transfer. Some researchers propose that in French, words are marked by an initial stress and a final lengthening and the initial stress has its linguistic function in marking a left phrase boundary (see the discussion by Astésano, Bard & Turk, 2002). Initial accent in French operates at the level of the minor phrase. When a word bears initial accent, the initial syllable is acoustically more prominent than the final syllable of that word. For instance, the word *chocolat* 'chocolate' can be read in three ways: (i) *CHO*colat (with initial accent on *cho*) and (ii) *choco**LAT* (with final accent only on the final syllable), and (iii) *chocolat* (without accent), as in e.g. *chocolat* *CHAUD* 'hot chocolate'. In the first reading with initial accent, the syllable *cho* is more prominent than the final syllable *lat*. Therefore, the assignment of primary stress on the leftmost syllable and secondary stress on the penultimate syllable in English quadrisyllabic non-words by Pater's French subjects could be explained as the transfer effect of French initial accent pattern. In summary, Pater's study is not a clear-cut case for the role of metrical parameters.

### 2.2.1.3. Learning Mechanisms

The previous two sections have reviewed the L2 English word stress patterns which are related to learners' L1 (either to stress patterns themselves or to language-specific phonotactics), and also those which are unrelated to learners' L1 and L2 but are still possible stress systems. We turn now to the issue of how the L2 stress system is acquired.

As previously noted, Archibald (1993b) and Pater (1997) explicitly claim that when a learner's native language is a stress language (e.g., Polish, Hungarian, Spanish or French), L2 English word stress is acquired via the mechanism of parameter-setting. This claim assumes that learners come to the task of learning a new stress system with a set of metrical parameters which have been set to the values of their L1, and that these settings might or might not be carried over to the development of the L2 stress system: they are reset (or sometimes mis-set) in subsequent development (Archibald, 1993b). The stronger evidence for this claim comes from Pater's study rather than Archibald's, partly because Pater's use of non-words avoids the problem of lexical memorization (this problem cannot be ruled out as an explanation for the results in Archibald (1993b)), and partly because the phenomenon attested in Pater (1997) is arguably independent of both L1 and L2, which seems to indicate that L2 learners construct an independent system by computing metrical structures under metrical parameterized principles (although as we have shown, Pater's parameter mis-setting account may not be as accurate as, e.g., an account in terms of the transfer of French initial accent).

On the other hand, other studies report that part of L2 stress patterns can be learned without invoking abstract phonological levels such as the construction of metrical feet. Davis and Kelly (1997), for example, propose an alternative account to the acquisition of stress in English disyllabic words: because the English noun-verb stress difference is such a superficial linguistic pattern, and because it is cross-linguistically so arbitrary, it is unlikely that they would be included in any core language learning faculty. They suggest instead that the kinds of knowledge which can not be included in the core language learning faculty should be learnable by

means of statistical learning from the distribution of input data. For instance, in the majority of English disyllabic words, part of the information in the lexicon shows a clear correlation between stress pattern and morphosyntactic category (e.g., initial stress correlates with nouns and final stress with verbs). If L2 learners can notice this correlation, then the English noun-verb stress contrast could be learned without reference to abstract aspects of phonology. Davis and Kelly provide evidence from native speakers of 15 different L1s, including both stress languages and non-stress languages. In their study, both native and non-native speakers of English were auditorily presented with disyllabic English nonwords and were asked to use these non-words in a sentence in any way they felt appropriate. They found that, for both native and non-native speakers, words with final stress were more likely to be used as verbs compared to words with initial stress. The second experiment they conducted was a speeded classification task, where subjects were presented with disyllabic real words and had to categorize them as nouns or verbs. Half of the nouns and verbs had initial stress and the other half had final stress. The non-native subjects were found to make more errors and were slower in classifying nouns with final stress compared to nouns with initial stress, and they were also slower and less accurate in classifying verbs with initial stress compared to verbs with final stress. Guion, Harada, and Clark (2004) also show that Spanish-English bilinguals preferred to assign the stress patterns of English disyllabic non-words by referring to both the morpho-syntactic categories and the segmental similarities of real words that they had already learned. The results of these studies can be used to suggest that the English noun-verb stress pattern was learned using the distributional information about the English lexicon to which they had already been exposed. In other words,



the acquisition of stress may not necessarily be subject to abstract metrical constituents or constraints: it is not necessary for L2 learners to correctly analyze English feet as uniformly trochaic rather than iambic; rather, they may treat stress patterns like  $\acute{\sigma}\sigma$  and  $\sigma\acute{\sigma}$  as un-analyzed chunks, and generalize their occurrence by correlating them with the two morpho-syntactic categories. So while the successful acquisition of the English noun-verb stress difference can be regarded from the perspective of metrical theory as a matter of re-setting the extrametricality parameter (Archibald, 1993a, 1993b), from this perspective it can be equally well construed as a matter of learning the broad statistical patterns of English stress patterns from available input data, i.e., using a much less constrained learning mechanism (Davis & Kelly, 1997).

As mentioned in Section 2.1.2.2, the knowledge of stress patterns constructed via statistical learning is gradient. That is, while the noun-verb stress contrast is learned, the knowledge is not in all-or-nothing, as if nouns were absolutely stressed on the initial syllable and verbs on the final syllable; rather, the gradient knowledge is expected to match the distributional facts of the ambient stress patterns. For instance, Kelly and Bock (1988) estimate that about 89-94% of English disyllabic nouns have initial stress whereas 31-46% of disyllabic verbs have initial stress; Sereno (1986) estimates that 76% of English disyllabic nouns have initial stress and 34% of English disyllabic verbs have initial stress. Although the estimates vary, the crucial point is that the difference is not 100% vs. 0%. Several studies have reported that native speakers are sensitive to the English noun-verb stress contrast, but their judgments are also gradient and generally reflect the frequency distribution in the input data. For example, in Guion, Clark, and Harada's (2004) production task



conducted with English native speakers, CV.CVCC non-words were assigned initial stress about 50% of the time when they were presented as nouns and 20% of the time when given as verbs. The perception results were much closer: about 40% vs. 33%. In Davis and Kelly (1997), native speakers judged 81% of initially-stressed disyllables as nouns and the rest (19%) as verbs. And 42% of the finally-stressed disyllables were treated as verbs and the remaining (58%) as nouns. Their results show that it is not only native speakers of English who show gradient judgments, but L2 learners do so too, and in the same direction as native speakers although to different degrees. In Guion, Clark and Harada (2004), the Spanish learners of English showed reduced differentiation in the production task, giving initial stress to CVCVCC non-words about 70% of the time when they were presented as nouns and about 60% of the time when presented as verbs, but they exhibited an exaggerated difference in the perception task: about 80% vs. 55%. The L2 learners in Davis and Kelly (1997) actually performed pretty close to the native speakers, treating 74% of the initially-stressed disyllables as nouns and 43% of the finally-stressed disyllables as verbs. Relevant to our study is the fact that half of the subjects, i.e., 12 out of 24, were speakers of non-stress languages (i.e., Mandarin, Cantonese, Korean and Japanese), and they also exhibited the gradient judgement of the English noun-verb stress contrast.

Although the distinction between “gradient” and “categorical” serves as a testing point for the two learning mechanisms, it can be seen from the above summary that the percentages in these experiments are all different: some match the actual distribution very well while others do not. Also, within studies, the results of perception and production match the distribution differently, and the results from

native and non-native speakers do not always coincide. In other words, the testing of the “gradient vs. categorical” distinction is easily affected by other factors in the experiment: the possibility that the matching or mismatching is an artefact of the experiments cannot be excluded. Furthermore, there is some debate over what the actual distribution is, and what the distribution is in the input which the L2 learners experience.

In summary, there is no general consensus among previous studies on whether parameter-setting or statistical learning acts as the main mechanism that guides L2 stress acquisition. While some studies argue that the parameter-setting mechanism can explain some L2 English stress patterns in certain language pairs, others show that some parts of English stress can be learned stochastically from the input in a wider range of interlanguage pairs.

### **2.2.2. English Word Stress Acquisition by Native Speakers of Non-stress**

#### **Languages**

In comparison with the amount of research on L2 stress acquisition by native speakers of another stress language, there are relatively few studies of the acquisition of L2 stress by native speakers of a non-stress language (i.e., tone languages or pitch-accent languages), in spite of its importance in understanding the relationship between L2 phonology and phonological theory as a whole. We now review the limited literature found in this area.

### 2.2.2.1. Evidence for L1 Transfer

One of the studies on L2 stress acquisition by native speakers of non-stress languages was conducted by Archibald (1997). In this study, he used the same design as the experiment from his earlier (1993b) study, presenting real words to three Chinese speakers and one Japanese speaker who were studying at an English language school after puberty. He collected production and perception data from the same subjects twice, with a 5-month interval in between. The results indicated that no significant progress in accuracy had been made over the five month period and that no systematic errors had emerged. Archibald therefore argued that these learners may have stored stress as part of each lexical entry, or in other words, without computing stress in terms of metrical cues such as vowel length or coda consonants. Also, since their perception of stress as a linguistic feature was generally poor, these learners may have stored incorrect stress patterns. Archibald argued that they did not acquire English stress systematically by referring to metrical cues, and that was why their performance fluctuated unpredictably. Based on his results, Archibald argued that the patterns transferred by native speakers of tone languages are quite different to those from native speakers of stress languages, and concluded that an explanation of L1 transfer at the metrical level was not justifiable for speakers of non-stress languages. However, Archibald provided no empirical evidence to support his argument that these subjects wrongly stored the stress patterns of the tested words. Therefore, a more conservative conclusion from his results would be that the subjects did not undertake the same kind of parameter-setting as Hungarian and Polish speakers. Whether their errors are caused by incorrect lexical storage or by some other factor

requires further investigation, as does the issue of whether a different generalization or metrical computation is involved.

In contrast, Juffs (1990) argued that the transfer of L1 prosodic properties did occur among Chinese learners of English who were freshmen at college. According to the theoretical foundations used in his study, English word stress can be realized by various phonetic correlates, among which pitch height is the most important. The higher the pitch of a syllable, the more it will be perceived to be stressed (Brown, 1977; Fry, 1958). However, pitch also plays a role in determining sentence stress in English, in the form of pitch movement (Brown, Currie, & Kenworthy, 1980). In this study, pitch was regarded as playing two roles in English: (a) word stress (in the form of pitch height) and (b) sentence stress (in the form of pitch movement). However, in Chinese, pitch movement is used in the realization of lexical tones. That is, while in English pitch height and pitch movement play roles at different phonological levels, in Chinese, both pitch height and pitch movement are important at the level of the word. In Juffs's study, nineteen L1 Chinese undergraduates read aloud a paragraph which contained 105 words. The results suggested that Chinese learners relied heavily on the pitch movement cue in determining word stress. For instance, they tended to assign a falling tone to the stressed syllable of test words (e.g., *civilizâtion*) regardless of whether it is stressed at the sentence level or not. Besides, Juffs also found that the syllable structure of Chinese influenced the assignment of stress in English words. The subjects' native language was Hunanese, a Chinese dialect in which the post-vocal nasal is analysed as a feature of the vowel (CṼ) rather than as a separate segment, i.e., CVN. The lack of CVN in this language seems to prevent these learners from treating CVN in English as heavy and assigning stress to the



CVN syllable. One of the examples given is the mispronunciation of the word *cóntinent* as *continént*. This type of errors are interpreted as the transfer effect that the initial syllable [kɒn] is not heavy in Hunanese so that these subjects failed to assign stress to it; instead, they assigned stress to the final syllable. Juffs's study therefore suggests that L1 transfer of lexical tone and syllable structure occurs among Chinese learners of English.

It should be noted that in Juffs (1990) the theoretical foundation for the relationship between stress and its phonetic correlates at the word and sentence levels is quite simplified (i.e., word stress in English is characterized in the form of pitch height and sentence stress in the form of pitch movement), and this has a negative influence on the validity of his interpretation of the empirical data he collected from his Chinese subjects. For a more in-depth analysis of stress at the lexical level refer to Beckman (1986), summarised in Section 1.2 of Chapter 1 above; for stress at sentence or utterance level, see Ladd (1996). Nevertheless, Juffs's findings are relevant to our earlier discussion in Section 1.2 about surface prosodic prominence in stress and non-stress languages and the phonological structure which underlies stress assignment. That is, at the word level, surface prosodic prominence in Chinese is characterized by tone, the movement of pitch height. Juffs's findings seem to show that Chinese speakers carry over this feature (i.e., pitch movement) onto L2 English stress assignment. In addition, even if Chinese and English are different in that Chinese uses tone as a feature of lexical contrast and English uses stress prominence, an L1 transfer effect could still come from the phonological structures which underlie stress assignment, e.g., syllable structure. In Section 2.4 below, we will also review the status of stress in Mandarin Chinese and discuss whether there is any possibility



that L1 transfer could occur.

Finally, Kawagoe (2003) also argues against Archibald's (1997) conclusion that Japanese learners of English do not engage in metrical computation when acquiring English stress. Kawagoe replicated Archibald's (1997) study and collected production data from 17 Japanese undergraduates reading aloud a list of real words both in isolation and in the context of sentences. She reported evidence for the transfer of the Japanese loanword accentuation system when native speakers of Japanese acquired English word stress. The Japanese accentuation system, proposed by Katayama (1995), is defined as "the final syllable is usually not stressed; heavy penults are stressed; and if the penult is light, then the antepenult is stressed", which is very similar to the stress system in English nouns. The transfer of this system ensured that Japanese subjects correctly produced the English nouns such as *a.gén.da* and *vé.ni.son*. Although Japanese and English are similar to each other in treating the final syllable as extrametrical, Kawagoe found that Japanese speakers sometimes assigned stress to the final syllable of English words when the syllable is CVVC (e.g., *hurricáne* and *carabíne*). Kawagoe suggests that this pattern might be due to the difference of what syllable structures are permissible in the two languages: Japanese allows CV and CVN whereas English allows a wider range of possible syllable types. In other words, extrametricality only applies to the final CV or CVN syllable in Japanese, so when these L2 learners encounter English words whose final syllable structure is not permissible in Japanese, they may not know to treat the syllable as extrametrical and therefore end up assigning stress to the final syllable. Kawagoe also found that the non-target-like application of extrametricality occurs more in the less successful group than in the more successful group, suggesting that there is a

gradual development of native-like application of extrametricality to more types of final syllables.<sup>12</sup> Assuming the framework of Optimality Theory, Kawagoe explains L2 English stress development as a process of re-ranking the constraints of the Japanese accentuation system and the Weight-to-Stress Principle (as explained in (2.10) and discussed further in Section 2.2.2.2 immediately below). Although Kawagoe does not explicitly discuss how the transfer of Japanese accentuation system into L2 English stress is possible, her findings seem to confirm our speculation made in Section 1.2 that notwithstanding their typological differences, Japanese and English are still similar to each other in that one syllable in each word is the most prominent and stands out from the others. This similarity might explain why transfer is possible even though Japanese has lexical pitch-accent and English has lexical stress.

To summarize, the findings on L1 transfer in L2 stress acquisition when learners' L1 is not a stress language are inconsistent, ranging from no transfer to the transfer of L1 prosodic properties, syllable structures and prosodic system. In addition, the different focuses of these studies, and inadequate phonological analyses of both the source language and the target language, make it difficult for us to evaluate what is transferred or whether metrical principles play a role in the acquisition of L2 English word stress by native-speakers of non-stress languages. Therefore, more empirical investigation is still required to clarify those issues.

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<sup>12</sup> The two groups were defined according to the proportion of subjects assigning antepenultimate stress to the trisyllabic non-words in the light-light-heavy sequence.

#### 2.2.2.2. Evidence for Universals

No known published study conducted to date shows that L2 word stress acquisition by speakers of tone languages exhibits patterns that are independent of both L1 and L2. To my knowledge, the only study which implies that universal metrical principles have any effect on L2 English stress acquisition by speakers of non-stress languages is Kawagoe (2003). By adopting the framework of Optimality Theory this study indirectly suggests that stress acquisition by native speakers of Japanese is constrained by universal parameterised principles since the constraints (or principles) are universal from the perspective of Optimality Theory.

One of the experiments conducted by Kawagoe (2003) investigated the stressability of the final syllable of trisyllabic non-words, i.e., the degree to which the final syllable was preferred to be stressed. These non-words followed a light-light-heavy sequence and the final heavy syllable took one of the following forms, CVVN, CVOO, CVVO, CVNO, CVO, CVN and CV (N indicates nasal consonant and O indicates obstruent consonant). Her results show that while the Japanese subjects tended not to assign stress to CV and CVN, they did assign stress to other syllable types to some degree. That is, CVVN syllables were assigned stress about 70% of the time, followed by CVOO syllables 55% of the time. The stressing of the other three syllable types, CVVO, CVNO, and CVO fell somewhere between the unstressed group (CV and CVN) and the stressed group (CVVN and CVOO). This seems to indicate that the Weight-to-Stress Principle plays a role in L2 English stress acquisition by Japanese speakers. As the final syllable of English nouns does not usually attract stress, the pattern which emerged here cannot be explained in terms of the L2. In addition, it cannot be attributed to Japanese either because only CV and

CVN are allowed in Japanese. However, the differentiation between the Japanese subjects' preferences for the different syllable types follows the universal WSP, in which superheavy syllables tend to be stressed, and then heavy syllables tend to be stressed too. In summary, Kawagoe's study presents the hypothesis that Japanese learners of English acquire English stress by transferring the loanword accent system in Japanese, and that their development can be seen as a process of modifying their loanword system to be English-like. The likelihood of the different syllable types being stressed generally follows the prediction of the universal WSP.

However, although Kawagoe shows that there is a preference towards stressing superheavy syllables in the seven kinds of syllable structure used in her experiment, and that this preference can be accounted for in terms of the universal WSP, it is not clear whether this pattern is independent of English at all. If it is, then we can treat it as evidence for metrical universals since there is an effect the universal WSP. However, if superheavy syllables are more stress-attracting than other syllable types in English, the universal account may be weakened. What this study shows is that Japanese speakers' assignment of stress to various syllable types is consistent with the WSP, but still the source of the WSP-like pattern needs more investigation. In our study we will re-examine this issue by differentiating the L2 learners' sensitivity to the stress mapping with heavy syllables and scrutinize what their sensitivity is based on (i.e., Weight-to-Stress Principle or the distributional patterns of the input data).

### **2.2.2.3. Learning Mechanisms**

Although parameter-setting is thought to be a plausible mechanism in the acquisition of L2 English stress by native speakers of stress languages (Archibald, 1993a, 1993b; Pater, 1997), no studies to date have suggested that native speakers of non-stress languages acquire L2 English stress via the parameter-setting mechanism. However, there is some evidence that both L1 stress and L1 non-stress learners acquire some aspects of the stress regularities in an L2, but since both parameter-setting and statistical learning can offer plausible explanations, it is still not clear which theory is more consistent with the data.

### **2.2.3. Summary of Sections 2.2.1 and 2.2.2**

A comparison of L2 English stress acquisition by native speakers of both stress languages and non-stress languages is presented in the following table, where the stress status of the source languages is taken from the author's view of the original studies (e.g., Archibald assumes that Chinese has no stress).



**Table 2.1.** *A comparison of claims about L2 English stress acquisition by speakers of stress and non-stress languages*

	<b>L1 background</b>	
	<b>Stress languages</b>	<b>Non-stress languages</b>
<b>L1 transfer</b>	<ol style="list-style-type: none"> <li>1. Polish learners transfer penultimate stress pattern onto English word stress (Archibald, 1993b)</li> <li>2. Hungarian learners transfer initial stress onto English stress (Archibald, 1993b)</li> <li>3. Spanish learners transfer phonotactic restrictions of syllables, which blocks the application of English extrametricality (Archibald, 1993a, 1998).</li> <li>4. French learners do not show transfer errors (Pater, 1997)</li> </ol>	<ol style="list-style-type: none"> <li>1. No systematic errors are found. Chinese and Japanese learners learn English stress via lexical storage rather than metrical computation (Archibald, 1997)</li> <li>2. Systematic errors are found. Chinese learners transfer the phonotactic restrictions of Chinese syllables when assigning stress (Juffs, 1990)</li> <li>3. The Japanese accentuation system is transferred as a basis for assigning English stress (Kawagoe, 2003)</li> </ol>
<b>Phonological Principles</b>	<ol style="list-style-type: none"> <li>1. French learners prefer L2 English stress patterns that are neither English target-like nor French-like; this is regarded as the mis-setting of foot parsing directionality and word headedness parameters (Pater, 1997)</li> </ol>	<ol style="list-style-type: none"> <li>1. Non-stress L1 learners learn English stress through lexical storage instead of metrical computation, which implies that metrical principles do not guide L2 acquisition (Archibald, 1997).</li> <li>2. Japanese learners can acquire English stress by re-ranking the constraints in the Japanese loanword accentuation system, implying that metrical principles do play a role (Kawagoe, 2003).</li> <li>3. No existing studies of speakers of tone languages learning English stress address the issue of universals</li> </ol>
<b>Learning mechanisms</b>	<ol style="list-style-type: none"> <li>1. L2 English stress is claimed to be acquired via the mechanism of parameter-setting (resetting or mis-setting) (Pater, 1997; Archibald, 1993b)</li> <li>2. Noun-verb stress regularity in English is claimed to be learned stochastically from distributional information in the input (Davis &amp; Kelly, 1993)</li> </ol>	<ol style="list-style-type: none"> <li>1. No evidence so far shows that L2 English stress can be learned via parameter-setting by native speakers of non-stress languages</li> <li>2. Stress typicality of the noun-verb contrast in English is claimed to be acquired stochastically by native speakers of non-stress languages, e.g. Chinese, Japanese, Cantonese (Davis &amp; Kelly, 1997)</li> </ol>

It can be seen from Table 2.1 that evidence for L1 transfer is widely attested in L2 English stress acquisition when the learners' L1 is also a stress language. On the other hand, there is a discrepancy between studies regarding whether or not L1 transfer occurs among L2 learners whose native language is a non-stress language. In fact, issues concerning L2 stress acquisition by native speakers of non-stress languages remain quite basic, such as whether or not their stress assignment in L2 is

even systematic (this will be discussed further in Section 2.3). Comparatively, very few studies have presented evidence for universals among native speakers of both stress languages and non-stress languages, other than one study of French learners of English and one of Japanese learners of English. No data has been collected to assess whether universals are found in the acquisition of L2 stress by native speakers of tone languages. Some studies argue that native speakers of stress languages acquire L2 English stress via parameter-setting, while others argue that statistical learning can explain the acquisition of at least some aspects of English word stress equally well. It is difficult to judge which mechanism plays the major role if the patterns can be explained in terms of both mechanisms. Finally, although native speakers of both stress and non-stress languages can acquire the L2 English stress typicality, the learning mechanism itself remains unclear; the data are consistent with both the statistical learning approach and the parameter-setting approach. This issue is addressed in one of our research questions.

## **2.3. Evaluation of Previous Findings**

### **2.3.1. Theoretical Considerations**

As we have seen, there are divergent findings regarding L2 word stress acquisition by native speakers of non-stress languages, including whether or not L1 transfer occurs and whether or not L2 English stress can be developed in a systematic way – Juffs (1990) argues that Chinese learners of English show L1 transfer effects, while Archibald (1997) finds no such evidence. One main reason why different conclusions have been drawn across these studies may be due to differing theoretical assumptions regarding learners' L1 phonological structures. Specifically, while Juffs (1990) and

Kawagoe (2003) explicitly compared the differences between learners' L1s and the target language, it is not clear what prosodic structures for Chinese and Japanese Archibald assumed in his analysis, making it difficult to evaluate the argument against L1 transfer. Regarding the Chinese prosodic system, there are good reasons for believing that Chinese syllables can either be light or heavy (see Section 2.4 below): therefore, whether or not those phonological units in Chinese have the same role in the development of L2 English stress as they have in the Japanese accentual system remains debatable.

### **2.3.2. Methodological Considerations**

In addition to the different assumptions of phonological structures in learners' L1, there are methodological issues in these studies which are also likely to lead to differing conclusions. The first issue relates to the number of subjects in each experiment. In most of the studies the number of subjects was greater than 15 (e.g., 23 Polish and 20 Hungarian subjects in Archibald (1993b), 19 Chinese subjects in Juffs (1990), 17 Japanese subjects in Kawagoe (2003), 57 French subjects in Pater (1997)), and all of these studies showed systematic patterns of L2 English stress. Only Archibald's 1997 study found that learners' errors were unsystematic, but in this study there were only 4 subjects: one Japanese speaker and three Chinese speakers. Of the three Chinese subjects, two were Mandarin Chinese speakers and the other was Cantonese, and the two Mandarin subjects were at different proficiency levels (the Cantonese subject's L2 proficiency was at Level 5 (out of 6), one of the Mandarin subjects was at Level 6 and the other at Level 3 (Archibald, 1997: 170)). The small sample size, the heterogeneity in language proficiency and the different L1

backgrounds all combine to cast serious doubts on the validity of the conclusion that no systematic patterns exist.

The second methodological consideration concerns the use of production tasks as a way of eliciting data, as it is generally acknowledged that the mapping between pronunciation and orthography in English is not always straightforward. Words with the same segmental composition and syllable structure may have different stress assignment. This variability in English word stress has been variously termed the non-uniformity of English stress (Pater, 2000) or flexibility (Kim, 2000), and has been treated differently in different theoretical analyses. Many phonologists regard one of the stress patterns as regular and the other as exceptional and marked in the lexicon (Alcantara, 1998; Halle, 1998; Halle & Vergnaud, 1987b; Hammond, 1999; Pater, 2000), but there is no agreement as to which pattern is the regular one and which is exceptional. For instance, trisyllabic words with the same CVCVCV sequence can be pronounced either in the strong-weak-weak pattern (as in *Cánada* [kænədə]) or in the weak-strong-weak pattern (*banána* [bənænə] or [bənúnə]). Other examples include *differ* vs. *defér*, *éssay* vs. *okáy*, *cóvert* vs. *ovért*. Therefore, when production data are used, the non-uniformity of English stress has to be carefully considered. For example, if the word *aroma* is read as [ærəmə], it conforms to the regular pattern in English (cf. *cinema*). This means when researchers analyze production data of L2 English stress assignment, as in Archibald (1993b, 1997), the segmental information must also be scrutinized in order to determine whether L2 learners' stress assignment is target-like or non-target-like. The same concern also applies when non-words are used. Perception tasks might be a better way of eliciting data in order to avoid the confounding interpretation of L2 English stress patterns.



The final consideration is the interdependent relationship that exists between segments and metrical structures. English stress relies on syllable weight, which is closely related to phonemic contrast. Specifically, English vowel pairs like /i/-/ɪ/ and /e/-/ɛ/ are contrastive both at the metrical level (i.e., light vs. heavy) and at the segmental level (i.e., lax vs. tense). Therefore, whether or not L2 learners are sensitive to syllable weight distinction is contingent on their ability to perceive these segmental contrasts. But the low front vowel is not found in some of the languages investigated in these studies (e.g., French and Spanish), and there is no contrast between /æ/ and /ɛ/ in Hungarian. The issue of whether or not the learners had acquired the relevant English vowel contrasts at the stage when they participated in the experiments is not discussed in any of these studies, and it is therefore not clear whether the stress errors are due to segmental or metrical difficulties or both.

### **2.3.3. Evidence for L1 Transfer and Metrical Universals**

Although Archibald (1993b) regards Polish speakers' preference for penultimate stress and Hungarian speakers' preference for initial stress as the transfer of L1 parameter-settings, it is not clear whether the transfer occurs in the form of parameter-setting at the metrical level (i.e., assigning stress to English words by constructing metrical feet according to the learners' L1 parameter-setting) or just in the form of unanalysed structure at the surface level (i.e., assigning stress to English words by referring to their L1 stress pattern without constructing metrical feet). Whatever differences exist between stress languages, they resemble each other in the phonetic parameters that make a syllable prominent. This phonetic similarity between stress languages may lead L2 learners of English to transfer their L1 stress



patterns into L2 English. In other words, when L2 learners are confronted with English words which are unknown to them, one strategy which they may adopt in order to make the words pronounceable is to pronounce them using the typical stress patterns of their L1. For instance, Polish has a stress system with fixed penultimate stress, and Polish speakers mostly assign fixed penultimate stress to English words, as attested in Archibald (1993b). This type of stress assignment does not necessarily involve the transfer of L1 parameter values: it could be due to phonetic similarities instead. A similar explanation applies to the case of Hungarian learners of English too, demonstrating that when a learner's L1 is a stress language, it is usually hard to determine the depth of the transfer of their L1 stress patterns. It could be as superficial as the transfer of unanalyzed stress chunks from their L1, rather than as deep as the transfer of the construction of metrical constituents based the settings of their L1 metrical parameters).

Similarly, when L2 learners assign target-like stress patterns to English real words, analysing this assignment as Archibald does as if these patterns are derived from metrical computation is not convincing since it does not exclude the memory-based account, which suggests that the stress patterns of real words are just stored on an item-by-item basis (see also Ou, 2003; Pater, 1997; van der Pas & Zonneveld, 2004). This is another factor which weakens the parameter-resetting account to some degree. In addition, although there are not many studies which report L2 stress patterns which are independent of both the L1 and the target language – the pattern that interests L2 phonology researchers the most – the existing studies which report this kind of evidence (Kawagoe, 2003; Pater, 1997) suggest that the non-target-like forms are derived from metrical principles and parameters. However, the arguments

presented above apply equally here: it is still unclear whether or not the observed patterns reflect a substantial role for metrical principles.

In summary, evidence for L1 transfer is widely reported, but the depth of the transfer is hard to determine. Stress patterns that are independent of L1 and L2 are also reported but it is not clear whether these patterns reflect metrical universals.

#### **2.3.4. Parameter-setting vs. Statistical Learning**

The noun-verb stress contrast in English disyllabic words can be systematically analyzed in terms of the setting of the two parameters QS-to [Rhyme] and Extrametricality. However, this contrast is also reflected in the distributional characteristics of the input data. The two possible analyses lead to at least two possible explanations about how the English noun-verb stress is acquired (i.e., parameter-setting and statistical learning). In order to distinguish the two learning mechanisms, a careful experimental design is needed. In particular, while parameter-setting accounts for how words with regular stress patterns in a language can be acquired via cross-word and cross-parameter comparison, statistical learning does not necessarily do so – stress patterns which are simpler and can be generalized based on the distributions of the input data are easier to learn than those which are complex or not apparent in the distribution. In Chapter 3, we will present an experiment which allows us to distinguish which learning mechanism guides L2 learner's acquisition of L2 English stress. And this issue will be further discussed in Chapter 5.

## 2.4. Key Characteristics of Chinese Phonology

Having introduced English word stress patterns, we turn now to the phonological characteristics of the source language in this study, Mandarin Chinese (hereafter, Chinese), and elaborate on some issues which are relevant to our purposes.

As mentioned in Chapter 1 (Section 1.2), Chinese is traditionally considered to be a lexical tone language, but the issue of whether Chinese has stress is quite controversial. Chen (2000: 289) provides the following review of what different analysts have said as to the stress status of Chinese:

A. Uniformly right-prominent

Chao (1968), Yip (1980), Lin (1983), Yue-Hashimoto (1987)

B. Free stress: predominantly iambic; some lexically marked trochees

Li (1981), Yin (1982)

C. Phrases mostly iambic; root compounds indeterminate

Kratochvil (1974)

D. Basically trochaic; iambs result from trochaic reversal, phrase-final lengthening, etc.

Chang (1992)

E. Non-head stress

Duanmu (1990, 1992, 1993, 1995)

F. Stressibility hierarchy: HL(>)HH>LH>LL

Meredith (1990)

G. Indifferent: no lexical stress

Gao and Shi (1963), Lin (1989), Du (1988), Duanmu (1993).

From the above, it is not difficult to see the degree of disagreement which exists over the stress status of Chinese. Each of these positions (A-G) is supported by at least one relevant property of Chinese. For example, positions (A-C) are based on the argument from duration and tonal stability. In many dialects of Chinese, the final syllable is usually longer in duration to allow for the implementation of the final tone. For example, the third tone in Mandarin Chinese usually has a stable contour and longer duration when it is located in the final syllable. When it is in non-final position, it is usually partly implemented phonetically, i.e., its realisation is not stable. These properties give rise to the analysis of Chinese as having a right-prominent or iambic pattern. On the other hand, if intensity is taken as a criterion of stress, then the initial syllable seems to be stressed because it has greater intensity. This criterion is taken by Positions (D) and (F), i.e., Mandarin Chinese has a trochaic stress pattern. It can be seen, therefore, that the conflict between these two views regarding stress in Chinese arises mainly from the elusiveness of a complete phonetic characterisation of stress. However, researchers who claim that Chinese has iambic or trochaic stress do not indicate that stress plays a role for lexical prosody. Meanwhile Gao and Shi (1963), Lin (1989), Du (1988), Duanmu (1993) explicitly take the position that Chinese has no lexical stress (position G).

It is necessary at this juncture to recall Wode's Crucial Similarity Measure (CSM), which claims that L1 transfer does not occur everywhere in L2 phonological acquisition, but only when learners find that there are some similarities between their L1 and the target language they are learning. This claim seems to hold when we look at the L2 stress data from native speakers of another stress language, but in the case of L2 stress acquisition by speakers of a tone language, the issue of transfer is not so



clear or straightforward. One problem is that if tone languages are radically different from stress languages, then learners will not find any equivalence between Chinese and English in terms of stress. In this case, one might expect that no pattern which is systematic with respect to Chinese phonological structure would occur, simply due to the lack of L1-L2 similarity. This seems to be the position that Archibald implies. On the other hand, despite the surface differences between tone and stress, a closer look at Chinese phonological structure reveals that there are some similarities between Chinese and English. Specifically, Chinese syllable structure has a basic similarity with English in the distinction that exists between “light” and “heavy” syllables, even though the distinction is made for different prosodic purposes (i.e., tonal association in Chinese and stress assignment in English). It is possible that this correspondence will have an effect on L2 stress assignment, and in this case, there may be a general effect of Chinese syllable structure on L2 English stress. The results from Juffs’s study seem to confirm this speculation. Both of these are possible scenarios and need to be tested empirically. This necessitates a discussion of tones (full tones vs. neutral tone) and their corresponding tonal structures (“heavy” vs. “light”).





As mentioned in Chapter 1 (Section 1.2), Chinese is typologically classified as a tone language since the phonological use of pitch height in this language is different from that in stress and pitch accent languages.<sup>13</sup> Mandarin Chinese has four lexical tones, shown overleaf, and in addition, these four tones can be neutralized in some contexts and surface as a short tone.

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<sup>13</sup> Whether or not stress is used in Chinese has been controversial (see Chang, 1992; Chao, 1968; Chen, 2000; Duanmu, 1990, 1993; Lin 1983; Yip, 1980), but no matter which position one takes on this, stress is not used to distinguish word meaning in Chinese.

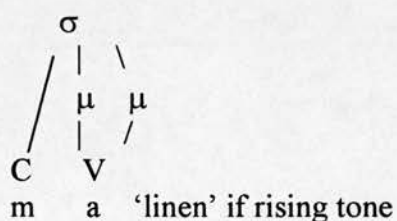
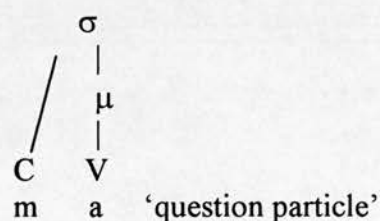


(2.31) *The four lexical tones in Chinese (Chao, 1968; Cheng 1973)*

- a. High Level     e.g., ma 'mother'
- b. Rising         e.g., ma 'linen'
- c. Low            e.g., ma 'horse'
- d. Falling         e.g., ma 'scold'

According to Duanmu (2000), full tones occur in syllables which have two time slots (or two moras, i.e., heavy syllables), whereas neutral tones occur in syllables which have only one time slot (or one mora, i.e., light syllables).

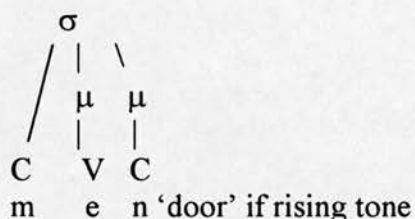
In addition, syllables in Chinese can be either open or closed. Open syllables can be either heavy or light. When an open syllable is associated with one of the four lexical tones, it is heavy. When the open syllable is associated with a neutral tone, it is light, as shown in (2.32).

(2.32) a. *Open syllable: heavy*b. *Open syllable: light*

It should be emphasized that the number of moras in Chinese vowels is not determined by vowel length, nor by tenseness, but only by tone. In other words, if tonal information is removed, it is impossible to determine whether an open syllable is light or heavy. On the other hand, all closed syllables are heavy, as shown in

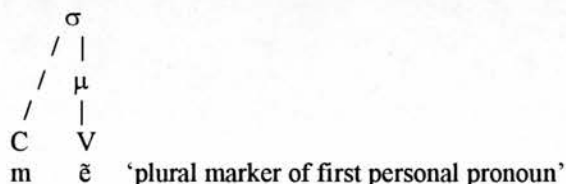
(2.33).<sup>14</sup> More importantly, only sonorant consonants /n, ŋ, r/ are allowed as coda consonants in Chinese: obstruent codas are not allowed.

(2.33) Closed syllable: heavy



It is also necessary to mention that there are five vowels in Chinese: /i/, /e/, /a/, /u/ and /y/ (e.g., Chao, 1968; Cheng, 1973; Duanmu, 2000). In English, vowels are contrastive both at the segmental level (lax vs. tense) and at the metrical level (lax = light vs. tense = heavy). Chinese vowels do not contrast this way. Put simply, Chinese vowels may be bimoraic or mono-moraic, depending on whether the syllable is associated with a full tone or a neutral tone and whether or not the syllable is followed by a consonant. When a full-toned syllable is not followed by a coda consonant, it is analyzed as bimoraic, as shown in (2.32 a). But if a full-toned syllable is followed by a consonant, it is analyzed as mono-moraic, as shown in (2.33). In neutral-tone syllables, Chinese vowels are always mono-moraic regardless of the presence/absence of a coda consonant, as shown in (2.32 b). It is quite possible

<sup>14</sup> Duanmu (2000) suggests that the traditional analysis, in which closed syllables are said to have neutral tones, should be revised so that they are analyzed in the same way as open syllables, i.e., an analysis where the coda is merged with the nucleus. For instance, when the syllable *men* is associated with neutral tone, its structure should be as follows:



that the differences in the way vowels contrast in these two languages will lead to difficulties when Chinese speakers acquire L2 English stress both segmentally and metrically.

A final point about Chinese phonology is that there is some evidence that the WSP plays a role in foot construction (e.g., Duanmu, 2000; Yip, 2002). It is argued that this principle plays a role in Chinese feet: in disyllabic words, if a full-toned syllable is followed by a neutral-toned syllable, the two syllables form a left-headed foot. On the other hand, if both of the syllables are full-toned (heavy), two separate bimoraic feet are formed to avoid violating the WSP (forming two full-toned syllables in a single left-headed foot would violate the WSP since the right-handed heavy syllable is not stressed (Yip, 2002). We mention this because the WSP plays an important role in English stress assignment (even though we do not assume that the use of this principle is the same in the two phonological systems, since the metrical constituents in different languages are said to interpret different prosodic phenomena (i.e., lexical tone in Chinese vs. lexical stress in English)). These are the characteristics of Chinese phonology which will be crucial for the rest of the thesis.

## **2.5. Chapter Summary**

This chapter has provided a detailed review of current research into L2 stress acquisition by native speakers of both stress languages and non-stress languages. This review has focused on three main issues, the effects of L1, the effects of metrical universals, and the mechanisms by which L2 stress may be learned.

For native speakers of a stress language, the main findings for L2 English stress acquisition were as follows. Firstly, evidence for the transfer of L1 stress

patterns onto L2 English stress assignment has been found for Polish, Hungarian and Spanish. Although error patterns can be simply interpreted as the transfer of surface stress patterns from the learner's L1, some studies further suggest that transfer occurs in the form of L1 parameter-settings. In addition, stress patterns which cannot be attributed to L1 and which are independent of L2 are attested in French-English interlanguage. These patterns are further interpreted as the reflection of a metrical universal – a stress system which is possible in terms of UG, yet not identical to either English or French and which is also found in children's stress acquisition. As for the learning mechanism which guides L2 stress acquisition, some studies posit that L2 English stress is acquired by means of parameter-resetting whereas other studies claim that English stress can be learned stochastically from statistical extraction based on the distribution of stress patterns in the input.

However, studies of native speakers of non-stress languages acquiring L2 English stress are relatively few, and the findings are inconsistent. The inconsistency ranges from very basic questions such as whether or not the L2 stress patterns are systematic to the issue of whether or not L1 plays a role. A study by Archibald (1997) found no systematic errors, while other studies did; some studies appeared to claim that L1 does play a role, whereas others conclude the opposite. Nevertheless, one study reported that patterns that were not directly related to L1 were found in Japanese-English interlanguage and their L2 stress patterns were consistent with the prediction of the Weight-to-Stress Principle. Although no studies have explicitly claimed that learners in this group could learn L2 English stress via parameter-setting, Davis and Kelly (1997) showed that L2 English stress could be learned stochastically if learners make use of the distribution of stress patterns in input data.



Some critical remarks were also made on three aspects of previous studies. One problem is the inconsistency of their findings due to differing theoretical assumptions. Another problem is lack of methodological rigour, one flaw being the lack of detailed analysis of production errors, which might have been influenced by the non-uniformity of English stress, and another flaw being the lack of controlling for the contribution of segmental knowledge to metrical computation. Thirdly, there are plausible alternative accounts to the published conclusions when real words are used in the experiments: although error patterns related to learners' L1 stress systems and the presence of the target-like patterns have been regarded as the product of parameter-setting, alternative explanations such as the transfer of L1 surface stress patterns and the memorization of stress patterns along with English lexical items are also possible. In addition, the issue of whether all stress patterns that are independent of L1 and L2 reflect metrical universals needs more consideration. Finally, whether L2 English word stress is acquired via parameter-setting or via statistical learning also requires more research.

Given these findings, we are particularly interested in investigating how L2 English word stress is acquired by native speakers of non-stress languages, and specifically, tone languages. At this point, the research questions which were formulated in Chapter 1 need to be re-formulated to take account of the controversy over whether there is in fact any systematicity in the stress assignments made by Chinese learners of English. This basic question becomes the first of the re-formulated research questions, as follows:

- a. Are L2 stress patterns in Chinese-English interlanguage systematic?



- b. Can the L2 stress patterns be explained in terms of learners' L1 and phonological principles?
- c. Are the observed patterns of development related to the learner's age of arrival or length of residence?
- d. What learning mechanism guides L2 English acquisition by Chinese speakers?

In investigating these four questions, we will also carefully address various problems that previous research has encountered. For instance, we will use non-words rather than real words to avoid the effect of lexical memorization. In addition, because Chinese does not contrast tense/lax (long/short) vowels as English, our L2 learners' knowledge about English vowels at the segmental level will also be carefully controlled in this study, so as to enable us to identify independent evidence for learners' L2 stress difficulties. Finally, because the general understanding of metrical universals in L2 stress acquisition is still very limited, we will also investigate whether or not the effect of metrical universals can be found in Chinese-English interlanguage.

The research agenda of next few chapters is set as follows. Chapter 3 presents a study which tests whether or not stress assignment by Chinese learners of English is systematic, and if so, what factors may contribute to its systematicity. Chapter 4 presents three experiments which investigate Chinese speakers' sensitivity to a proposed universal mapping between stress and syllable structure (i.e., syllables containing a long vowel or a coda consonant tend to be stressed). Similarly, if systematic patterns emerge, the contributing factors will also be investigated. Chapter 5 discusses the learning mechanism which best accounts for the observed

data and presents the theoretical implications of this study for the field of L2 phonology. Finally, Chapter 6 presents some further issues and concludes the whole study.

## **CHAPTER 3**

# **EXPERIMENT 1: STRESS PREFERENCES FOR DISYLLABIC AND TRISYLLABIC NON-WORDS**

### **3.1. Introduction**

In this chapter we investigate the learning mechanisms which guide L2 stress acquisition by testing the acquisition of English word stress by native speakers of Mandarin Chinese. In order to do this, we need to first ascertain whether the L2 English stress patterns acquired by L1 Chinese speakers show any systematicity.

In Chapter 2, we showed that several studies demonstrate that L2 learners whose native language is a stress language can assign systematic stress patterns to both real words and non-words of English (which is also a stress language). On the other hand, very few studies have been conducted to investigate the acquisition of English stress by L2 learners whose native language does not have lexical stress (e.g., Mandarin Chinese). In addition to the rarity of the extant studies, the findings from the limited literature available are inconsistent and controversial, particularly in relation to issues such as whether or not speakers of tone languages learning English can assign accurate stress to real English words, whether or not their errors are systematic, and whether or not they can assign stress to English non-words systematically or in a similar manner to native speakers of English. For these reasons, our understanding of how English word stress is acquired by native speakers of non-stress languages is very limited, even though this area is crucial for understanding the

nature of L2 phonology as a whole. Therefore, the goal of this chapter is to explore what if any general patterns of L2 English stress can be attributed to the learners' L1 (Chinese) or phonological universals on the basis of controlled experiments. Some of the controversial issues which are left unresolved by previous studies will be addressed and clarified by the results of these experiments.

The first empirical question to test is whether or not the learners assign English stress systematically. If systematic patterns do emerge, then we can ask whether or not the patterns are similar to those observed in native speakers of English. If the patterns are systematic but not similar to those of English native speakers, we must investigate the source(s) of the difference, i.e., L1 transfer effects, universal tendencies or other factors. Once the patterns and the underlying factors are revealed, we can then explore the learning mechanism which guides the acquisition of these patterns, i.e., whether statistical learning based on the distribution of stress patterns in the input data vs. the setting of UG metrical parameters.

Two well-studied patterns of English word stress are tested. The first one is the stress contrast between nouns and verbs in disyllabic words with a CVCC final syllable. Stress usually falls on the initial syllable when the disyllabic word is a noun, but on the final syllable when it is a verb, as shown in (3.1).

(3.1) *Stress patterns of disyllabic nouns and verbs*

initial stress: *insect, forest, second* (n.)

final stress: *molest, detect, accept* (v.)

In the metrical stress theory of English, the generalization for (3.1) is mainly analyzed as the difference between Noun Extrametricality and Consonant Extrametricality and the effect of the WSP, as introduced in Section 2.1.1.1: in nouns,

the final syllable is extrametrical, so stress falls on the initial syllable of a disyllabic word (e.g., *ín<sect>*); in verbs, only the final consonant is extrametrical (e.g., *mo.les<t>*), and stress falls on the final CVC syllable due to the effect of WSP (*mo.lés<t>*). This is the metrical explanation of the noun-verb stress contrast in English words of the  $\sigma$ .CVCC pattern. However, the noun-verb stress contrast can also be analyzed in a non-metrical way (i.e., from the perspective of distributional patterns), as presented in Section 2.1.1.2. That is, according to the overall distribution of stress patterns in English, regardless of final syllable structure, disyllabic nouns tend to have initial stress whereas disyllabic verbs tend to have final stress (see example (2.19) in Chapter 2). For example, according to Sereno's (1986) estimate, 76% of English disyllabic nouns have initial stress and 66% of disyllabic verbs have final stress. A similar distribution is also reported by Kelly and Bock (1988) although the values are not exactly the same: about 89-94% of English disyllabic nouns have initial stress whereas only 31-46% of disyllabic verbs have initial stress. Both metrical and non-metrical analyses are related to the issue of which learning mechanism guides the acquisition of this contrast by L2 learners. To emphasize again, the metrical analysis in this study means that stress assignment in the target language is regarded as the product of metrical constituents by means of setting the metrical parameters of UG to construct metrical feet and prosodic words. On the other hand, the non-metrical analysis refers to how stress patterns can be acquired through the mapping between surface stress patterns and some sort of cues in the input data to the contrasting stress patterns, without necessarily involving the construction of abstract metrical constituents. The issue of learning mechanisms is



further addressed in Chapter 5; meanwhile, the main concern of this chapter is whether or not Chinese speakers can learn this stress contrast.

The second pattern of English stress which is tested here is the stress difference in trisyllabic nouns, i.e., where antepenultimate stress is assigned when the penult is CV and penultimate stress is assigned when the penult is CVC. This is exemplified in (3.2).

(3.2) *Stress patterns of trisyllabic nouns*

antepenultimate stress: *Cá.na.da*, *cí.ne.ma*, (CV penult)

penultimate stress: *a.gén.da*, *sur.rén.der*, (CVC penult)

In the metrical stress theory of English, this phenomenon is analyzed as the product of both Noun Extrametricality and the Weight-to-Stress Principle (WSP). Put simply, the final syllable of trisyllabic nouns undergoes Noun Extrametricality first (e.g., *Caná<da>* and *agen<da>*). Then, if the penult is heavy (due to having a coda consonant (CVC)), stress falls on the penult due to the WSP (e.g., *a.gén.da*). If the penult is light (CV), then stress falls on the antepenultimate syllable (e.g., *Cá.na.da*). Again, however, these patterns have an alternative, non-metrical (or distributional), analysis. The distribution of English stress patterns in trisyllabic nouns is one in which the majority of trisyllabic nouns with a CV penult have antepenultimate stress and those with a CVC penult have penultimate stress. The distributional facts will be presented in detail in Chapter 5; for now, these patterns can simply be analysed as the correlation between  $\sigma$ .CV. $\sigma$  structure and antepenultimate stress and the correlation between  $\sigma$ .CVC. $\sigma$  structure and penultimate stress (see example (2.20) in Section 2.1.1.2). Note that an unanalyzed stress chunk in this context is isomorphic to a word.

By choosing disyllabic words with a CVCC final syllable, and trisyllabic nouns with a CV or CVC penult, we will not only be able to re-examine whether or not Chinese speakers can assign stress systematically, but, if systematic patterns do emerge, we will also be able to evaluate which learning mechanism guides their acquisition. This is because the metrical analyses of both the noun-verb stress contrast and the stress difference in trisyllabic nouns rely on the same phonological applications, namely the WSP. Therefore, if the noun-verb stress contrast is acquired metrically rather than statistically, we should expect to see the same metrical sensitivity to the CVC penult in trisyllabic nouns in the same learners. In other words, controlling the syllable structure allows us to investigate whether the L2 English stress system is acquired metrically or statistically.

In addition to these two regular stress patterns, English stress is also characterized by a large number of exceptional cases. The term “exceptional” used here is from the metrical point of view. In the non-metrical analysis, these cases are simply part of the distribution of English stress patterns (see examples (2.19), (2.20) and (2.21) in Section 2.1.1.2). For instance, stress sometimes falls on the penult in trisyllabic nouns, even when the penult is light (e.g., *dilémma* and *vanilla*), while in other words the penultimate syllable is closed by a coda consonant but stress still falls on the antepenultimate syllable (e.g., *calendar*, *chemistry*). These patterns are also mentioned in most of the literature on English phonology and metrical stress theory (e.g., Giegerich, 1992; Hammond, 1999).

### 3.2. Method

We conducted a preference task, which was related to the two English stress patterns outlined above, namely, the noun-verb stress contrast in  $\sigma$ .CVCC words and the stress difference conditioned by the syllable structure of the penultimate syllable in trisyllabic nouns.

#### 3.2.1. Materials

In order to avoid any effect of lexical memorization, we followed the approach of other researchers in using non-words (Guion, Clark, Harada, & Wayland, 2003; Guion, Harada, & Clark, 2004; Kawagoe, 2003; Pater, 1997). In order to control for factors such as “exceptional” cases and phonological similarities, the non-words were carefully designed. First, two hundred pseudo-words of two and three syllables were constructed. They all followed English phonotactic rules and syllable occurrence restrictions, based on Hammond (1999). Five native speakers of English were then interviewed and asked to read these non-words aloud based on their intuitions of how they should sound as potential English words. The stress patterns which they used were noted down. Based on how the native speakers realised these non-words, a subset of eighty non-words was chosen. All eighty had stress patterns which were agreed upon by at least four of the five native speakers (i.e., 80% agreement), and which matched the English stress generalizations stated above. Any items which violated the general English stress patterns were ruled out even if they were highly agreed among native English speaking subjects – for instance, the word *chálinder* was ruled out because the stress did not fall on the heavy penultimate syllable, violating the general tendency of the mapping between CVC and stress in

English. In addition, some native subjects pointed out that this word was reminiscent of real words such as *cáalendar*, and the stress pattern of *calendar* is not canonical in English (compare words like *agénda* and *enígma*).

After this initial selection process, the eighty non-words were put into carrier sentence frames either as nouns or verbs. Three native speakers of English were asked to read these sentences aloud. Finally, 32 words which were assigned the same stress patterns by all three native English speakers were chosen as the experimental materials. This design procedure ensured that the test words used in the tasks were all phonotactically legitimate, and that their stress patterns were by and large regular.

The resulting 32 non-words in carrier sentences were pre-recorded in a sound recording studio by a female phonetician, a native English speaker from North America.<sup>1</sup> The reason we chose a speaker with a North American accent is mainly because that is the variety which learners of English in Taiwan are primarily exposed to. She practiced reading the lists of sentences out loud at a comfortable rate and spacing the sentences equally. With the objective of obtaining naturally and consistently produced sentences, a block elicitation method was used which allowed the speaker to maintain the same rhythmic pattern and segmental quality across comparable items. Firstly, the sentences were recorded in the block with initial stress and then in the block with final stress. After a break, the sentences were recorded in a pair-by-pair fashion, and additional repetitions were allowed when she felt dissatisfied with her previous recording. The productions were recorded on DAT tape. The sentences from the last repetition of the second block were used for the stimuli. The recordings were digitized at 22.05 kHz (16 bit) on a personal computer.

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<sup>1</sup> According to the speaker, she shows neutralization of /ɪ/ and /ɛ/ before nasals. However, this does not influence the result of our experiments.



### 3.2.1.1. *Non-words Targeting the Noun-Verb Stress Contrast*

Sixteen of the non-words were disyllabic and had a CVCC final syllable. Eight of them were nouns and the other eight were verbs. The final syllable was always CVCC so that any effect caused by the two extrametricality rules (i.e., Noun Extrametricality and Consonant Extrametricality) could be observed. Specifically, the initial syllable would receive stress in nouns i.e.,  $\acute{\sigma}.<CVCC>$  while the final syllable would receive stress in verbs i.e.,  $\sigma.C\acute{V}C<C>$ . In order to indicate the part of speech of these non-words, two carrier sentence frames were designed: for nouns the frame was, "The \_\_\_\_\_ is [a monosyllabic colour term]," and for verbs the frame was, "She/He is easy to \_\_\_\_\_." Each non-word had two stress patterns: initial stress and final stress e.g., *dré.sect* vs. *dre.séct*. All the test items are listed in Appendix 1.

### 3.2.1.2. *Non-words Targeting the Stress Contrast in Trisyllabic Nouns*

Sixteen of the non-words were trisyllabic. Two kinds of target syllables were designed: eight of the non-words had a light penult (CV), e.g., *na.ti.pa*, and eight had a heavy penult (CVC), e.g., *ba.sil.ka*. The target syllables all contained the front high lax vowel /ɪ/. This vowel was chosen because it could be reliably elicited due to the high grapheme-phoneme correspondence between -i- and /ɪ/, and also because it can occur both in stressed and unstressed syllables, thus allowing for the manipulation of stress without categorical changes of vowel quality. The coda consonants were chosen from four categories: nasals, liquids, fricatives and stops. Each of these had two tokens. The final syllable was either CV, CVV or CVC, and in all cases it was produced with a reduced vowel. The antepenultimate syllable was also CV, CVV or



CVC, and in the case of antepenultimate stress, it is produced with a full vowel whereas in the case of penultimate stress, it is produced with a reduced vowel.

Each non-word was given two stress patterns, antepenultimate stress (e.g., *ná.tim.pa* /náɪtɪmpə/) and penultimate stress (e.g., *na.tím.pa* /nəɪtɪmpə/). Each pair of words was then embedded in the carrier sentence frame which indicated that it was a noun (e.g., *The \_\_\_\_\_ is blue*). All of the test items are shown in Appendix 1.

### 3.2.2. Subjects

The L2 subjects comprised 20 native speakers of Taiwanese Mandarin who were acquiring English. They were all postgraduate students at the University of Edinburgh. They are referred to simply as the Chinese subjects from now on.

Table 3.1 presents detailed information for each subject: age, age of arrival in the UK/US (AOA), age when formal English instruction began in the native country (Learning Age), length of residence in the UK/US (LOR), and language proficiency test scores. The average age is 26.7 years (SD = 4.4). Note that there are two countries (UK/US) listed in AOA: this is because some subjects had lived in the US before they came to the UK to study. In this case, their AOA shows the age they arrived in the US rather than the UK. Three subjects had never received any formal English instruction in their native country, and so their arrival ages were taken as their values for the learning age variable. Two subjects had never taken a proficiency test.

**Table 3.1.** *Characteristics of Chinese speaking subjects*

Subject	Age	Learning age	AOA	LOR (years)	Language Test score
5	34	13	33	1	6.0 (IELTS)
6	33	13	30	3	7.0 (IELTS)
9	20	12	12	8	643 (TOEFL)
12	21	9	9	10	--
13	25	15	18	7	8.0 (IELTS)
14	23	10	10	13	--
15	26	11	25	1	7.5 (IELTS)
16	25	11	24	1	6.0 (IELTS)
17	28	13	27	1	6.0 (IELTS)
18	26	13	25	1	6.0 (IELTS)
19	34	14	33	1	6.5 (IELTS)
21	24	11	23	1	5.5 (IELTS)
22	25	8	24	1	8.0 (IELTS)
23	24	14	22	2	587 (TOEFL)
24	30	14	27	3	7.5 (IELTS)
25	27	13	25	2	7.5 (IELTS)
26	33	13	14	19	8.0 (IELTS)
27	24	13	23	1	8.0 (IELTS)
28	24	12	23	1	5.5 (IELTS)
71	29	13	26	3	7.5 (IELTS)

Note: AOA=Age of arrival in the UK/US. LOR= length of residence in the UK/US. Length of residence is rounded to the nearest year.

The proficiency tests were either IELTS or paper-based TOEFL. In order to make the scores comparable, the approximate equivalences of the scores of the two tests (published by University of Sheffield English Language Teaching Centre) are shown in Table 3.2 for reference.

**Table 3.2.** *Approximate equivalences of IELTS and TOEFL scores*

TOEFL (paper-based)	625-680	600	575	550	525
IELTS	7.5-9.0	7.0	6.5	6.0	5.5

Twenty English native speakers also participated in the experiment for comparison. All of the English subjects were also either postgraduate or undergraduate students at

the University of Edinburgh. None reported having been diagnosed with any language or reading disorders.

Each subject in both groups was paid £2 for participating in the experiment.

### 3.2.3. Procedure

The items were presented randomly, controlled by E-Prime software (Psychology Software Tools, 2001). In each trial, subjects were given a visual presentation of the sentence, e.g., *He is easy to dresect.*, where the non-word was underlined. The sentence was displayed for 2000 msec, then two sound stimuli were presented one after the other in random order, with a 500 msec pause between the two stimuli (e.g., [hi ɪz izi tə drəsɛkt] and [hi ɪz izi tə drésekt]).

Participants were tested individually in a sound-insulated booth, which contained a desktop computer and high quality headphones. Two keys on the keyboard were labelled '1' and '2', where '1' indicated the first sound stimulus and '2' the second sound stimulus. In each trial, the task was to determine which pronunciation of the non-word in the sentence they heard was more likely to be a potential English word, and then to indicate their decision by pressing the appropriate button. There was an interval of 1000 msec between each trial, which was calculated from the point when a button was pressed from the previous trial. When in doubt he/she was asked to guess. No replay was permitted. A practice session with 5 pairs of sound stimuli was prepared to allow the subjects the opportunity to adjust the volume of the presentation to a comfortable level and to allow them time to familiarize themselves with the task.

### 3.2.4. Results and Discussion

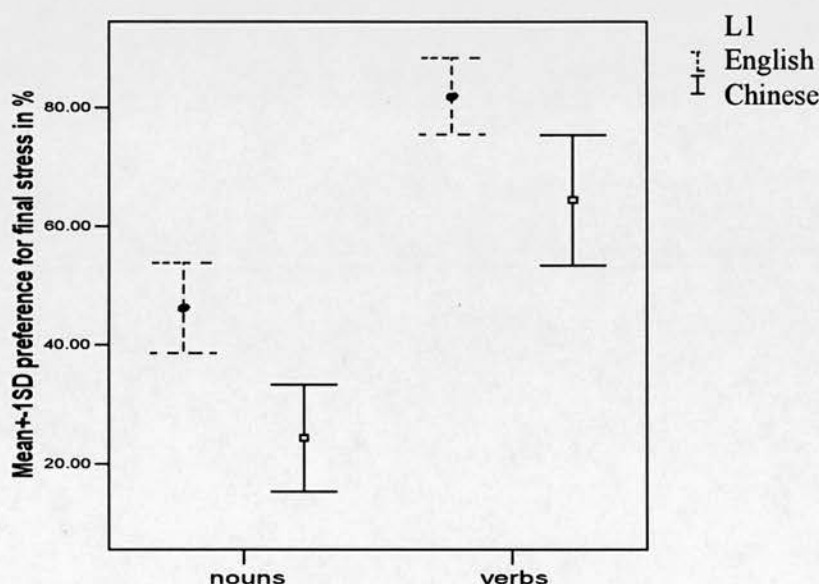
#### 3.2.4.1. Stress Preferences for Disyllabic Nouns and Verbs

The prediction was that if Chinese learners of English were sensitive to the noun-verb stress contrast, they would prefer initial stress for nouns (e.g., *dré.sect* rather than *dreséct*) but prefer final stress for verbs (e.g., *va.réct* rather than *vá.rect*). Table 3.3 and Figure 3.1 show the English and Chinese speaking subjects' stress preference for nouns and verbs.

**Table 3.3.** *Preferences for final stress according to nouns and verbs*

	Nouns	Verbs
	Mean (s.d.) in %	Mean (s.d.) in %
Native speakers of English (N = 20)	46.2 (16.3)	81.9 (13.7)
Chinese learners of English (N = 20)	24.4 (19.2)	64.4 (23.4)

**Figure 3.1.** *Responses to final stress in CV.CVCC noun and verb non-words*



There was a significant main effect for the two factors MORPHO-SYNTACTIC CATEGORY [ $F(1,38) = 81.94$ ;  $p < 0.01$ ] and FIRST LANGUAGE [ $F(1,38) = 23.05$ ;  $p < 0.01$ ]. There is no interaction between MORPHO-SYNTACTIC CATEGORY

and FIRST LANGUAGE [ $F(1,38) = 0.27$ ; n.s.]. The results show that both groups preferred penultimate stress for nouns and final stress for verbs, and that Chinese speaking subjects have a similar stress pattern preference to the English subjects. This suggests that Chinese learners of English are sensitive to the effect of morpho-syntactic categories on stress assignment, a result which challenges Archibald's (1997) finding that Chinese learners of English assign stress unsystematically. This result also agrees with Davis and Kelly's (1997) finding that the noun-verb stress contrast can be learned by speakers of both stress languages and non-stress languages.

However, although both groups exhibit a similar tendency in the noun-verb stress contrast, the exact values are different (the main effect of L1). Looking at the Chinese subjects' performance, it turns out that the results match the general distribution of English stress patterns very well, e.g., Sereno's (1986) estimate that 76% of English disyllabic nouns have initial stress matches our result that the Chinese subjects preferred the disyllabic nouns to have initial stress in 76% of the cases. And the estimate that 66% of disyllabic verbs have final stress matches our result that the Chinese subjects preferred disyllabic verbs to have final stress 64% of the time. Therefore, one possible explanation for these results is that these learners track the general statistical distribution of English stress patterns when acquiring the noun-verb stress contrast regardless of the final syllable structure. Although the English subjects also show a similar tendency, the matching is not so close. As mentioned by Guion, Harada, and Clark (2004), there are more factors contributing to native subjects' stress assignment of non-words than to non-natives. For example, Guion and her colleagues report that syllable structure has a significant role to play for English native speakers while the effect of syllable structure is not significant for



late Spanish-English bilinguals. This might explain why the values in two groups are different, although the exact factors are unidentifiable in this study. For instance, Guion and her colleagues showed that English native speakers prefer initial stress when the initial syllable contains a long vowel rather than a short vowel (e.g., CVV.CVCC is preferred over CV.CVCC) and they prefer final stress when the final syllable contains a long vowel rather than a short vowel (e.g., CV.CVVC is preferred over CV.CVC). However, this tendency was not found in late L2 learners of English (i.e., native speakers of Spanish). Nevertheless, our result strongly suggests that these L2 learners' sensitivity to the English noun-verb stress contrast is just as good as the English control subjects'.

We turn now to the question of how the noun-verb stress contrast may be acquired by these Chinese subjects. Even though the results from the Chinese subjects show a neat match with the distribution of English stress patterns, it is still uncertain whether their knowledge is learned via statistical extraction or via parameter-setting. This is because, as noted in Section 2.2.1.3, matching may be sometimes caused by experimental artefacts, such as the properties of the non-words used in the experiment. Specifically, since there are just two stress patterns in the experiment, it is hard to determine how neatly the distributional values and the experimental results should match with each other, before we can conclude that the learners are indeed tracking the distribution of stress patterns in the input data. In previous studies which have investigated the relationship between speakers' phonotactic wellformedness judgments and the probabilistic patterns of the ambient language (e.g., Hay, Pierrehumbert and Beckman (2004)), there are more structures used in their experiment (e.g., the cluster *nt* is attested, *mθ* is unattested and *mf* is in-

between). This allows the researchers to do the correlation analysis to see the relationship between subjects' judgment and distributional patterns. But in the case of our study, this is impossible. Therefore, it is suggested that more evidence should be provided in order to say that these learners acquire English stress statistically. In addition, although our results match neatly with Sereno's (1986) frequency report of stress patterns of English disyllabic words, the matching is not so close to other researchers' estimates, such as Kelly and Bock's (1988), suggesting that the interpretation of statistical learning simply based on the matching between experimental results and the frequency of the input data is not always reliable. Hence, we will leave the discussion of this issue until this result can be compared with the results of the other tasks.

In summary, the results from the disyllabic noun-verb stress contrast shows that Chinese speaking subjects used some form of generalization instead of pure lexical storage in acquiring L2 English stress; therefore, they were able to systematically assign stress to non-words. However, the nature of generalization is not yet clear, i.e., whether it comes from metrical computation or statistical extraction.

#### **3.2.4.2. Stress Preferences for Trisyllabic Nouns**

The second component of the preference task tested whether or not the Chinese learners of English were sensitive to the stress attraction in the heavy penultimate syllable (CVC) of trisyllabic nouns. The prediction was that if Chinese learners of English were sensitive to the stress contrast associated with the syllable structure of penultimate syllables, they would prefer antepenultimate stress when the penult was

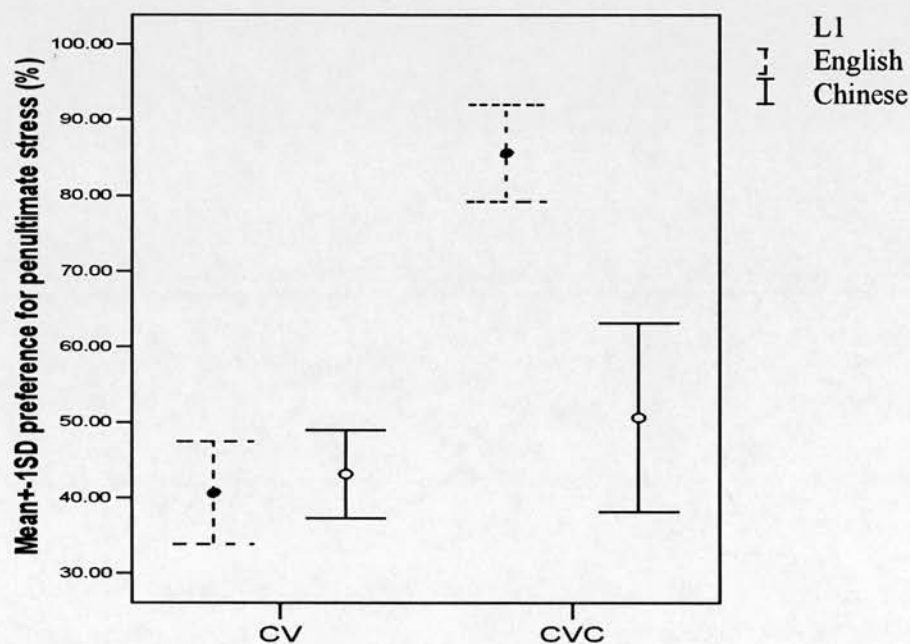
CV (e.g., *ná.ti.pa* rather than *na.tí.pa*), but when the penult was CVC they would prefer penultimate stress (e.g., *ba.síl.ka* rather than *bá.sil.ka*).

The results presented in Table 3.4 and Figure 3.2 show the preference for penultimate stress in the two different syllable structures (CV and CVC) shown by the two groups (Chinese and English).

**Table 3.4.** *Preferences for penultimate stress according to type of penultimate syllable (CV and CVC)*

	CV	CVC
	Mean (s.d.) in %	Mean (s.d.) in %
Native speakers of English (N = 20)	40.6 (14.6)	85.6 (13.7)
Chinese learners of English (N = 20)	43.1 (12.5)	50.6 (26.7)

**Figure 3.2.** *Responses to penultimate stress according to type of penult (CV and CVC)*



There were significant main effects for both factors, SYLLABLE TYPE [ $F(1,38) = 55.13$ ;  $p = 0.000$ ] and FIRST LANGUAGE [ $F(1,38) = 13.75$ ;  $p = 0.001$ ]. In addition, there was a significant interaction between SYLLABLE TYPE and FIRST

LANGUAGE [ $F(1,38) = 28.13$ ;  $p = 0.000$ ]. The English subjects preferred antepenultimate stress when the penult was CV but penultimate stress when the penult was CVC, whereas the Chinese subjects showed no difference of stress preference between CV and CVC. There was, however, a large amount of variability ( $SD = 26.74\%$ ) in the CVC results across the Chinese subjects. A more detailed look into the data reveals that eight of the Chinese speakers had a preference score for stressed CVC penults which was within  $\pm 2SD$  of the native speakers' mean. T-tests confirmed that there was no significant difference in the preference for penultimate stress in words with a CVC penult between these 8 Chinese subjects and the 20 English subjects ( $t(26) = 1.25$ , n.s., two-tailed), while there was a significant difference in the preference for penultimate stress in words with a CVC penult between the 8 successful Chinese subjects and the other 12 less successful Chinese subjects ( $t(18) = 7.19$ ,  $p = 0.000$ , two-tailed). In the terms of the metrical analysis, these 8 Chinese speakers can be regarded as showing a native-like sensitivity to the weight distinction illustrated in (3.3), i.e., the heaviness of the CVC penult.



More interestingly, this tendency for penultimate stress appears to be conditioned by the sonority of the coda consonant in these successful 8 subjects. In the test words with a CVC penult, penultimate stress is preferred when the coda consonants are nasals or liquids while antepenultimate stress is preferred when the coda consonants are fricatives or stops, as shown in Table 3.5 (overleaf).



**Table 3.5.** Chinese group response to the types of coda consonants (sonorant vs. obstruent) and preference for stress patterns (penultimate vs. antepenultimate)

	$\sigma$	' $\sigma$	$\sigma$	' $\sigma$	$\sigma$	$\sigma$	$\chi^2(1)$
<b>Sonorant coda</b>	91%	(N = 29/32)		9%	(N = 3/32)		22.13, $p < 0.01$
<b>Obstruent coda</b>	63%	(N = 20/32)		37%	(N = 12/32)		

However, the same tendency is not found in the group of English native controls, as shown in Table 3.6.

**Table 3.6.** English group response to the types of coda consonants (sonorant vs. obstruent) and preference for stress patterns (penultimate vs. antepenultimate)

	$\sigma$	' $\sigma$	$\sigma$	' $\sigma$	$\sigma$	$\sigma$	$\chi^2(1)$
<b>Sonorant coda</b>	84%	(N = 67/80)		16%	(N = 13/80)		0.66, n.s.
<b>Obstruent coda</b>	88%	(N = 70/80)		12%	(N = 10/80)		

To my knowledge, there is no literature on English phonology that reports a tendency for syllables closed by a sonorant coda to attract stress more than syllables closed by an obstruent coda. In order to confirm this, a corpus-based analysis was carried out with the CELEX database. All trisyllabic words in the corpus with a penultimate syllable containing a lax vowel and a single coda consonant were classified according to the location of their primary stress. The results show that the syllables closed by a sonorant consonant do not attract stress any more than those closed by an obstruent consonant, as shown in the following table, where type frequency refers to the count of word types (i.e., lexical items) in which the penult contains a certain type of coda consonant (i.e., sonorant or obstruent) while token frequency refers to the count of word occurrences containing a certain type of coda consonant in each million running words recorded in the corpus.

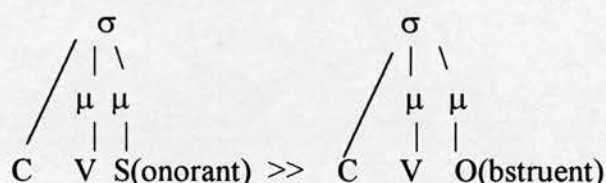


**Table 3.7.** *Stress patterns in English trisyllabic nouns when the penultimate syllable contains a lax vowel followed by either a sonorant consonant or an obstruent consonant (N = 316)*

	Type frequency		Token frequency	
	óσσ	σσó	óσσ	σσó
Coda type in the penultimate syllable				
Sonorant consonant	33% (N = 54)	67% (N = 110)	32% (N = 458)	68% (N = 987)
Obstruent consonant	40% (N = 61)	60% (N = 91)	37% (N = 631)	63% (N = 1062)

This shows that the preference of the eight Chinese subjects for assigning penultimate stress when the penultimate syllable is closed by a sonorant consonant rather an obstruent is independent of the patterns of the input data. Nevertheless, it is consistent with the cross-linguistic tendency for more sonorous codas to contribute to syllable weight (Zec, 1988). This is illustrated in (3.4), where “>>” means “is more weight-contributing than”.

(3.4)



It may also be the case that the Chinese subjects' preference is due to the transfer of L1 syllable structure. As reviewed in Section 2.4 above, Chinese allows only sonorant codas (i.e., /n/, /ŋ/ and /r/).<sup>2</sup> In other words, Chinese has CVS(onorant), which is always heavy, but CVO(bstruent) does not exist. So if this is transferred,

<sup>2</sup> One might argue that Taiwanese permits obstruent codas and they may be transferred because some of these learners are bilingual speakers of Mandarin Chinese and Taiwanese. But even if Taiwanese does allow obstruent codas, they are weightless. Syllables ending in an obstruent coda are never associated with contour tones.

learners will treat English CVS as heavy but will not know what to do with CVO. This makes it plausible that they are more sensitive to the weight contributed by sonorant codas than that contributed by obstruent codas, and this is what our results show.

Returning now to the discussion of the stress difference between  $\sigma$ .CVC. $\sigma$  and  $\sigma$ .CV. $\sigma$  words, in the terms of the non-metrical analysis, it can be said that these eight L2 learners have generalized a pattern such as, “when the penultimate syllable is closed by a coda consonant, then penultimate stress is assigned; if not, then antepenultimate stress is assigned.” This is essentially the same generalization as follows from the metrical analysis, but crucially it does not rely on more abstract notions such as the construction of metrical feet.

Furthermore, as pointed out by Guion, Harada, and Clark (2004), the assignment of stress to non-words is multifaceted, and influenced by at least three factors: lexical classes, syllable structure and phonologically similar words. In English disyllabic words, the effect of lexical classes is the most conspicuous. In trisyllabic words, in addition to syllable structure, phonologically similar words also play an important role, so the subjects’ stress assignment to trisyllabic words may have involve both factors. Although our analysis above hinges on the factor of syllable structure, it is possible that the L2 subjects assigned stress based on the stress patterns of any phonologically similar words they were familiar with. Even though phonological similarity was taken into account in the design of the test words in this study, and the test words were checked carefully by native English speakers to remove any items which were too similar to real words, it is still worth checking whether this factor plays a role in the assignment of stress by our L2 learners. If the

effect of phonologically similar words is significant, our account of metrical and non-metrical analyses above will be weakened because syllable structure is not the only source for these L2 subjects to assign stress. On the other hand, if the effect of phonologically similar words is very minor or insignificant, our account above will be justified further.

In order to examine whether or not analogy to phonologically similar words played a role, more data were collected from the 8 subjects who showed the native-like pattern. They were presented with a piece of paper, as shown in Appendix 2, which listed the 16 trisyllabic non-words, and they were asked to write down any words which they considered similar to those non-words. If they could not come up with any word for a particular item, they were allowed to leave it blank. They were given two minutes to complete the task. The number of words collected was 52 in total. Most of these words were disyllabic: only eighteen out of the 52 words were trisyllabic. Only the eighteen trisyllabic responses were examined. The eighteen trisyllabic words were classified according to stress location, i.e., antepenultimate stress vs. penultimate stress, as shown in Table 3.8. Twelve of them (67%) had antepenultimate stress, while only six (33%) had penultimate stress. Among the twelve words with antepenultimate stress, only eight had stress patterns which matched the eight subjects' stress preference, as shown in top half of Table 3.8. Since the words they provided as being similar had predominantly antepenultimate stress, it does not appear that they were basing their preference on any perceived similarity

with known words with penultimate stress. Therefore, phonological similarity does not seem to account for the L2 learners' stress preferences in our experiment.<sup>3</sup>

**Table 3.8.** *Stress patterns of real words produced by Chinese subjects*

	Antepenultimate stress	Penultimate stress
Words that match the subjects' stress preference		
pomisto		permission (x2)
natipa	national (x2)	
varimi	vitamin, various	
terimy	terrible, terrify	
Words that do not match the subjects' stress preference		
pomisto	pacify	tomorrow (x2); together (x2)
natiskus	nautical	
tokifer		
bemfimpus	benefit (x2)	
natimpa	Nottingham; narrowing	

The exclusion of phonological similarity as a factor in these subjects' stress preferences in our experiment strengthens our argument that these learners' stress assignment is based on some sort of linguistic structure such as the syllable structure of the penult.

A further point for detailed investigation was whether there were any common characteristics shared by these 8 more native-like subjects which could explain their stress preferences for CVC vs. CV penults. A stepwise multiple regression analysis was run to examine the relationship between all L2 subjects' preference for penultimate stress on CVC penults and four other variables: Age, AOA, LOR, and Learning age. The criterion variable was all the L2 subjects' preference for the stressed CVC penult (in %) and the predictor variables were Age, AOA, LOR and Onset of English instruction. As summarized in Table 3.9, the

<sup>3</sup> Because the non-words were chosen by 7 native speakers, those which could easily be associated with real words should have been significantly eliminated. It may also be difficult for the learners to make analogies with longer words.

procedure selected AOA as the factor that best predicts the Chinese subjects' preference for stress on CVC penults. None of the other factors made statistically significant contributions to accounting for the residual variance.

**Table 3.9.** *Summary of stepwise regression analyses for the relation between L2 subjects' variables and the L2 subjects' preference for penultimate stress on CVC penults (N = 20)*

<b>Variable entered</b>	<b>B</b>	<b>SE B</b>	<b>Beta</b>
AOA	-2.593	0.673	-0.672*
Variables Excluded	Beta	<i>t</i>	<i>p</i>
Age	0.129	.538	0.597
Learning age	-0.029	-0.150	0.883
LOR	0.151	0.536	0.599

Note: \* $p < 0.05$

However, a high level of correlation was found between AOA and LOR ( $r = .774$ ,  $p < .01$ ), suggesting the possibility that the stepwise analysis erroneously rejected LOR from the model due to collinearity. This was because all but one of the subjects who arrived in UK/US before or around puberty were also the youngest of our participants, studying undergraduate programmes at the university; those participants who came to the UK/US for postgraduate programmes were older. To probe further into the relative effects of AOA and LOR, we ran a forced entry regression, and compared a model with only AOA as a predictor and model with both AOA and LOR as predictors. As summarized in Table 3.10, adding LOR increases  $R^2$  by 0.009, but this change is not significant. A scatterplot of AOA against L2 subjects' preference is shown in Figure 3.3.

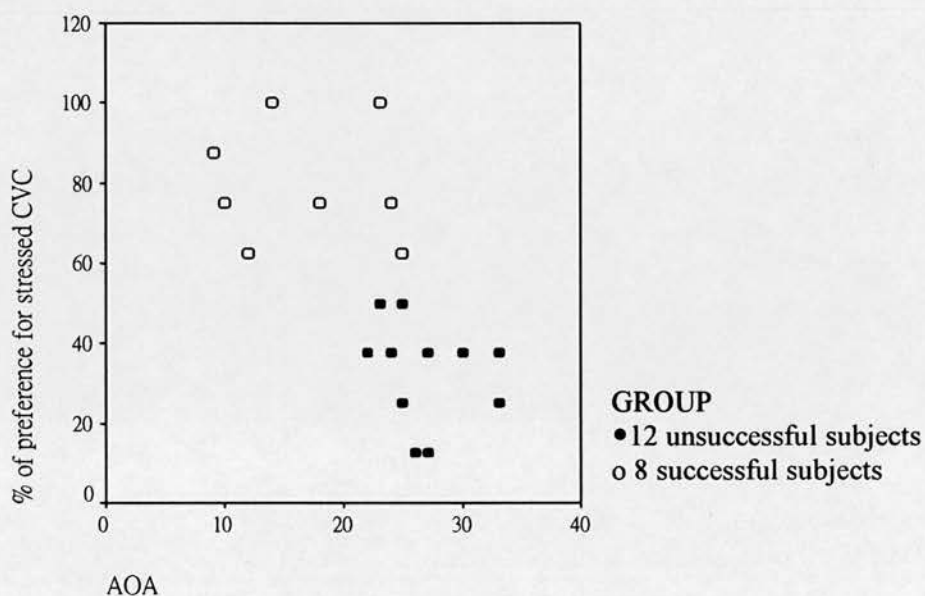


**Table 3.10.** *Summary of forced entry regression analysis for the relation between two subject variables (AOA and LOR) and the L2 subjects' preference for penultimate stress on CVC penults (N = 20)*

Variable entered	B	SE B	Beta
Step 1			
AOA	-2.593	0.673	-0.672*
Step 2			
AOA	-2.143	1.085	-0.556
LOR	0.804	1.051	0.151

Note:  $R^2 = 0.42$  for Step 1;  $\Delta R^2 = 0.009$  for Step 2 (n.s.). \* $p < .05$

**Figure 3.3.** *Relationship between L2 learners' stress preference for CVC and their age of arrival in the UK/US*



As reviewed in Chapter 1 (Section 1.1.2), the effect of AOA is widely acknowledged in the literature, but previous research has produced somewhat mixed results on the effect of LOR, with studies disagreeing on whether a correlation can be found between LOR and the perceived foreignness of the L2 accent (e.g., Tahta, Wood, & Loewenthal, 1981; Riney & Flege, 1998). Oyama (1976) claimed that AOA but not LOR could predict the degree of foreign accent. Piske, MacKay, and Flege (2001) argued that the discrepant findings on LOR effects can be unified under

the interpretation that both LOR and AOA can be predictors at the early stages of L2 acquisition, but the effects of LOR taper off in later stages. This suggestion is plausible, because no matter how young L2 learners are when they arrive in the community of the target language, if they have not been exposed to the L2 long enough, their proficiency level cannot be particularly high. Our result fits the view proposed by Piske, MacKay, and Flege (2001): AOA is a better predictor of L2 learners' phonological proficiency after the earlier stages of L2 acquisition.

To summarise: there were eight L2 subjects who showed native-like sensitivity to the stress contrast conditioned by the syllable structure of the penult in trisyllabic nonsense nouns. Since there was no significant effect of the factor of phonologically similar words, attributing the results to the effect of syllable structure in this study is well justified. However, whether the information of syllable structure used by these eight subjects is metrical (i.e., arising from the construction of feet based on syllable weight projected by the syllable structure) or non-metrical (i.e., the mapping of two analyzed stress chunks with two types of penult structure) is another issue, and one which will be discussed more fully later on (Chapter 5). In addition, AOA was found to serve as a good predictor for the acquisition of the stress contrast which is conditioned by syllable structure: the earlier they arrived in their English-speaking communities, the greater their sensitivity to such stress contrasts is.

### **3.3. General Discussion**

This section offers a general discussion of the results from the preference task. Since the same subjects participated in the stress assignment of both disyllabic and trisyllabic non-words, and since there was a large amount of variation in the stress

preferences for trisyllabic nouns, a further question to explore is whether any different developmental patterns appear between the L2 learners when a by-subject analysis is undertaken for the preference task.

For the distinction between initial stress and final stress in disyllabic nouns and verbs, both groups made a significantly greater choice of final stress for verbs rather than nouns. These results presented in Section 3.2.4.1 were based on the group analyses, but it may not be the case that this contrast is found in all the L2 learners in our study. Here we define the stress contrast as the difference of stress preferences for disyllabic verbs and disyllabic nouns, i.e., the ratio of final stress in verbs minus the ratio of final stress in nouns. This enables a comparison to be made for each subject in the two groups, as shown in Table 3.11.

**Table 3.11.** *By-subject analysis of the noun-verb stress contrast*

<b>% final stress for verbs - % final stress for nouns</b>	<b>English Group (Subject No.)</b>	<b>Chinese Group (Subject No.)</b>
-25%	0	1 (21)
0%	1 (59)	3 (13, 17, 28)
12.5%	4 (57,58,61)	2 (5, 25)
25%	2 (42,48)	2 (12, 23)
37.5%	6 (43,45,48,49,62)	1 (19)
50%	5 (41,46,52,54,63)	4 (9, 14, 22, 26)
62%	1 (53)	2 (15,16)
75%	1 (51)	4 (6,18,24,71)
87.5%	0	1 (27)
	Mean = 36.63%	
	(s.d. = 19.14%)	

Nineteen of the 20 Chinese subjects have a contrast score within  $\pm 2SD$  of the native speaker's mean. These speakers can be said to exhibit native-like sensitivity to the noun-verb stress contrast. In addition, one of these 19 subjects (Subject 27) shows an even more dramatic contrast than the English natives. Only one Chinese subject's

performance does not fall within this range and is considered to be insensitive to the noun-verb stress contrast in English.

For the trisyllabic nouns, we have seen that eight Chinese subjects were sensitive to stress difference conditioned by CV and CVC penults. Table 3.12 shows the combined result of the Chinese subjects' stress preferences in disyllabic non-words and trisyllabic non-words, where the tick "✓" indicates that they are sensitive to the given contrast and the cross "✗" means they are not sensitive to that contrast.

**Table 3.12.** *Behaviour of the Chinese subjects in the two stress types*

Chinese subject	Noun-Verb stress contrast in disyllabic words	Penultimate stress in trisyllabic nouns with CVC penults
12	✓ (25%)	✓ (87.5%)
22	✓ (50%)	✓ (75%)
14	✓ (50%)	✓ (75%)
27	✓ (87.5%)	✓ (100%)
9	✓ (50%)	✓ (62.5%)
13	✓ (0%)	✓ (62.5%)
25	✓ (12.5 %)	✓ (62.5%)
26	✓ (50%)	✓ (100%)
15	✓ (62.5%)	✗ (25% )
16	✓ (62.5%)	✗ (37.5%)
18	✓ (75%)	✗ (25%)
24	✓ (75%)	✗ (12.5%)
6	✓ (75%)	✗ (37.5%)
71	✓ (75%)	✗ (12.5%)
19	✓ (37.5%)	✗ (37.5%)
23	✓ (25%)	✗ (37.5%)
17	✓ (0%)	✗ (37.5%)
28	✓ (0%)	✗ (50%)
5	✓ (12.5%)	✗ (25%)
21	✗ (-25%)	✗ (50%)

The first pattern which can be seen in the table is that the 8 L2 subjects who were sensitive to the stress attraction in trisyllabic words are also sensitive to the noun-verb stress contrast. The second pattern is that eleven L2 subjects show native-like



sensitivity to the noun-verb stress contrast without showing native-like sensitivity to stress difference in trisyllabic nouns. The third pattern is lack of native-like sensitivity to both the English stress patterns; this is the case with one subject. There is also a fourth developmental pattern which is logically possible, namely, one in where L2 learners show native-like sensitivity to stress difference in trisyllabic nouns but not to the noun-verb stress contrast, but none of the subjects show this developmental pattern. These results indicate that the actual pattern of development is more restricted than would logically be predicted. The presence of the second developmental pattern and the absence of its mirror pattern (the fourth possible pattern) shows that knowledge of the noun-verb stress contrast has been acquired no later than knowledge of the rightward stress attraction in trisyllabic nouns. This suggests that the stress-related cue of morpho-syntactic categories is easily attainable for L2 speakers while the stress knowledge related to syllable structure is less easy to develop. This point has some implications for the learning mechanism which guides the acquisition of stress, and this is discussed further in Chapter 5.

Here we consider the question of why the stress contrast which is conditioned by syllable structure (or syllable weight) might be less easy to learn for L2 learners. Since we have found that our L2 subjects' stress sensitivity is strongly correlated with their age of arrival (AOA), one possible explanation is that sensitivity to phonological structure may decline for late L2 learners. In fact, Guion, Harada, and Clark (2004) also show a similar result: among the three factors they investigated for stress assignment in English non-words, lexical class and phonological similarity but not syllable structure were significant factors for late Spanish learners of English, whereas all three factors were significant for early learners and native speakers.



A final point to make in this discussion is that our conclusion that Chinese-speaking learners are less sensitive to syllable-structure-conditioned stress contrasts than to the noun-verb stress contrasts rests on at least three assumptions. Firstly, it was assumed that these L2 learners had been able to distinguish lax and tense vowels in English and they had known the implication of syllable weight of lax vowels. That is, when a syllable contains a lax vowel only (CV), it is light and tends not to receive stress; on the other hand, when a syllable contains a lax vowel and a coda consonant (CVC), it becomes heavy and tends to receive stress. However, in this experiment these learners' ability of identifying lax and tense vowel was unknown since their first language, Mandarin Chinese, does not have such a contrast, and no independent test was carried out to test their ability to perceive the difference. A related assumption made was that the vowel /ɪ/ (the vowel used in the trisyllabic non-words) was not misperceived as a schwa. But if these two phonetically similar vowels were in fact confused, it would have led to poorer performance in this task. The third assumption which we made was that in trisyllabic English words, a penultimate syllable containing the vowel /ɪ/ has a predictable stress pattern depending on whether the syllable is closed or open. However, the situation is slightly more complicated than that. The vowel /ɪ/ is not only a lax 'full' vowel but also one of the reduced vowels (along with /ə/, and /ʊ/). Therefore, a C/ɪ/C syllable could either be a stressed syllable with a full vowel or else an unstressed syllable with a reduced vowel. We will discuss this issue in greater detail in Chapter 5.

Since none of these assumptions was fully justified in this experiment, we must for the time being weaken the tentative conclusions drawn above. In the meantime,

several modifications in the design and stimuli of the experiment can be identified so as to overcome these limitations. First of all, the L2 learners' perception of English lax and tense vowels should be tested independently, to ensure that they can detect the segmental difference which carries the relevant weight implications. Secondly, non-reduced lax vowels other than the vowel /ɪ/ need to be included in order to circumvent the problem associated with the ambiguous status of the vowel /ɪ/ in English. Thirdly, we also suggest that vowel length should also be included as a control factor since not only the shape of the syllable (i.e., open vs. closed), but also the quantity of the vowel (i.e., short or long) that affects the likelihood of a syllable being stressed. The implementation of these modifications is presented in Chapter 4.

### **3.4. Chapter Summary**

In this chapter, two types of stress preference were elicited from Chinese and English subjects in order to answer a general question relating to L2 English word stress acquisition by Chinese learners of English, namely, whether or not these learners assign English word stress systematically. We now summarize the main findings.

In disyllabic non-words with a CVCC final syllable, Chinese subjects preferred initial stress when the non-words were presented as nouns, but they preferred final stress when the non-words were presented as verbs. In trisyllabic nouns, penultimate stress was preferred when the penult was closed by a consonant (CVC) whereas antepenultimate stress was preferred when the penult only contained a lax vowel (CV). These results clearly indicate that Chinese speakers make systematic generalizations in acquiring L2 English stress rather than storing stress on an item-by-item basis.

Since these systematic patterns did emerge but were not exactly native-like, it was possible to go on to investigate the possible underlying factors behind this. Detailed analysis revealed that 8 of the learners were more successful than the rest, in that their sensitivity to the stress difference conditioned by the CV/CVC penult was just as well as English natives. These successful learners showed a stronger preference for stress on syllables with a sonorant coda compared to those with an obstruent coda, a pattern which can be explained either as a universal effect of sonority-weight interaction or as an L1 transfer effect due to the lack of CVO(obstruent) in Mandarin Chinese. It was also found that AOA was a useful predictor of the L2 learners' sensitivity to the stress difference conditioned by the syllable structure of the penult in trisyllabic nouns.

In addition, by-subject analyses revealed that (i) eight subjects were sensitive to both the noun-verb stress contrast in disyllabic words and to the stress difference in trisyllabic nouns, (ii) one subject was sensitive to neither contrast, (iii) eleven subjects were sensitive to the noun-verb stress contrast but not sensitive to the stress difference in trisyllabic nouns, and (iv) there were no instantiations of the mirror pattern of (iii). The significance of patterns (iii) and (iv) is that they have a bearing on the timing of acquisition: since (iii) was attested but not (iv), the acquisition of the noun-verb stress contrast and the stress difference in trisyllabic nouns were different in timing. More importantly, it suggests that the noun-verb stress contrast is acquired earlier than the stress difference in trisyllabic nouns. This finding is crucial for the main concern of this thesis, namely the learning mechanisms which guide L2 word stress acquisition, and will be explicitly discussed in Chapter 5.

Finally we identified some methodological limitations in the design and stimuli of the trisyllabic component of the experiment, which complicate the interpretation of the results. These included (i) the possibility that the L1 learners were not able to distinguish lax and tense vowels in English when they participated in the experiment, (ii) the possibility that learners had misperceived the vowel /ɪ/ and schwa /ə/, and (iii) the ambiguous status of the vowel /ɪ/. In order to add weight to our conclusions, one more investigation of these L2 learners' sensitivity to the stress differences was carried out. This is done in Chapter 4, where the methodological problems encountered in this chapter will be resolved.

## **CHAPTER 4**

# **EXPERIMENT 2: THE ACQUISITION OF THE UNIVERSAL MAPPING BETWEEN STRESS AND SYLLABLE STRUCTURE**

### **4.1. Introduction**

In Chapter 3 we showed that Chinese learners of English are able to show systematic stress preferences for English non-words, an indication that these learners engage in some sort of generalization when they learn English word stress rather than purely storing stress on an item-by-item basis. In addition, these L2 learners were found to be more successful in the task which was designed to measure their sensitivity to the noun-verb stress contrast than in the task intended to measure their sensitivity to the stress difference conditioned by the CV vs. CVC penultimate syllables of trisyllabic nouns.

Although one possible explanation for the findings of Chapter 3 is that these L2 learners were less sensitive to the stress contrast which is conditioned by the presence/absence of the coda consonant in the penultimate syllable of trisyllabic nouns, other factors may be involved in their sensitivity/insensitivity to the distinction between CV and CVC. Since the experiment in Chapter 3 showed non-words both visually and auditorily, we had to restrict the vowel used in the target syllables (CVC and CV) to the high front lax vowel /ɪ/. However, using the vowel /ɪ/



to test the Chinese learners' sensitivity to the stress contrast had the drawback that it is not only one of the lax vowels (as opposed to the class of tense vowels) but also one of the reduced vowels in English. As a reduced vowel, its phonological status is equivalent to schwa /ə/, so it never receives stress regardless of whether it appears in a closed syllable (C/ɪ/C) or in an open syllable (C/ɪ/). The second limitation was that the short vowel /ɪ/ is not phonemic in Chinese. It is not clear, therefore, whether or not those learners who failed to show the stress shift associated with the C/ɪ/C penult had acquired this English vowel when they participated in the experiment. For example, they might have misperceived it as the long vowel /i/ because in Chinese vowels are mostly long due to being associated with full tones. If this was the case, CVC and CV would both have been perceived as being long, and no stress contrast can be expected for these speakers. Even if they did perceive it as short, there is still a problem because of the confounding status of the vowel /ɪ/ in English just mentioned. Because of these drawbacks, it becomes harder to ascertain which level their difficulties in the task should be attributed to. For example, they may have acquired the contrast between English lax and tense vowels phonemically at the segmental level, but not the implications of the two vowel types at the metrical level (i.e., light vs. heavy). Alternatively, they may not have acquired the contrast either phonemically or suprasegmentally, which would mean that the claim about their insensitivity to the mapping between stress and syllable structure needs to be qualified since the difficulty is not only stress-related but also phoneme-related. In fact, there are many studies reporting that L2 learners have great difficulties in perceiving and producing vowels in the target language (Baker, Trofimovich, Mack,

& Flege, 2002; Flege, Bohn, & Jang, 1997; Flege & Mackay, 2004), and this difficulty also found in L1 Chinese speakers (Wang, 1997, 2002; Wang & Munro, 1999). Since the interest of this thesis is in identifying learners' problems in the acquisition of L2 English word stress (at the suprasegmental level), a more careful control of the L2 learners' knowledge at the lower prosodic levels is necessary.

Another factor which conditions the mapping between stress and syllable structure is vowel type. In Chapter 3 only the contrast between CV and CVC penults was tested: a more complete investigation should also include the contrast between CV and CVV (i.e., syllables containing a long vowel). The aim of this chapter is therefore twofold. One aim is to remedy the methodological problems of the previous experiment. The other is to include vowel length as a contributor of syllable weight.

The main task conducted was similar to that of Chapter 3, namely, a stress preference task. However, in order to control for the learners' knowledge of L2 segments, a screening test was given before the main preference task. The details of the experiment are as follows.

## **4.2. Method**

### **4.2.1. Screening Test**

The aim of the screening test was to select L2 learners who were capable of distinguishing lax and tense vowels in English. The test was an identification task, for tense and lax vowels of English monosyllabic words.

#### 4.2.1.1. Materials

Two pairs of vowels, /ɪ/-/i/ and /ɛ/-/e/, were chosen as the test targets because these two pairs of vowels are contrastive in all English dialects. Twenty-four pairs of monosyllabic real words (e.g., *bit-beat*, *tell-tail*) were assembled as test words (these are given in Appendix 3). Twelve pairs of monosyllabic filler items with other phonemic contrasts (e.g., *big-pig*) were also included.

The materials were recorded on DAT in a sound-attenuated room. The words were read by a female native English speaker from Canada, who was resident in the United Kingdom for 8 years. She practiced reading the lists several times before the formal recordings. She was told to read the word list at a comfortable rate and to try to space the words equally. Repetition was allowed if she was not satisfied with her previous reading. The recorded sounds were then digitalized at 22.05 kHz (16 bit) and segmented into individual files for each word, and finally all the files were normalized in amplitude.

All the thirty-six pairs of monosyllabic words were presented randomly, controlled by E-prime. In each trial, word pairs such as *bit-beat* were orthographically displayed on the screen, and then of one of the two words, e.g., /bit/, was played auditorily to the subjects.

#### 4.2.1.2. Subjects

Data was collected from two groups of subjects: (1) fifty-three Chinese learners of English, who were either postgraduate students in Edinburgh or undergraduate/postgraduate students in Taiwan, and (2) twenty native speakers of English, studying at the University of Edinburgh. The L2 learners of English had had

experience of learning English for at least 8 years, with their ages ranging from 22 to 46 years old (mean = 27.80 years; SD = 4.50). None of them had majored in linguistics or been trained in phonetics and phonology. The twenty native speakers of English were included as a control group.

#### **4.2.1.3. Procedure**

Subjects were tested individually in a sound-insulated booth, which was equipped with a desktop computer and high quality headphones. Two keys were labelled as 'Left' and 'Right' on the keyboard, where 'Left' indicated the word shown on the left half of the screen and 'Right' indicated the words shown on the right half of the screen. Subjects were told that they were going to see two words and then hear one sound in each trial. Their task was to determine which word matched the sound stimulus they heard by pressing the appropriate key. Each trial after the first started 1000 msec after their response to the previous stimulus. Subjects were asked to make a guess if they were unsure. A practice session with 5 pairs of sound stimuli was provided before the experimental trials.

#### **4.2.1.4. Results and Discussion**

Identification rates of vowels in the control group ranged from 91.7% (22 correct out of 24) to 100% (24 correct out of 24). The high level of accurate responses by native speakers of English indicated the validity of the test items.

On the other hand, the performance of the 53 Chinese subjects was more varied. Their correct responses ranged from 41.7 % (10 correct out of 24) to 100% (24 correct out of 24), indicating that some of them could not distinguish lax/tense



vowels in a native-like way. It has been widely reported that L2 learners have great difficulty perceiving or producing vowels in target languages (Baker, Trofimovich, Mack, & Flege, 2002; Flege, Bohn, & Jang, 1997; Flege & Mackay, 2004; Wang, 1997, 2002; Wang & Munro, 1999). Since our aim was to select the learners who were capable of distinguishing lax and tense vowels in English, a criterion needed to be set for selecting the Chinese subjects who could be regarded as having the ability to accurately identify lax and tense vowels in English. The threshold was set at 2SD below the mean of the control group, or 91.7% (22 correct out of 24). There were 20 Chinese subjects in total who met this criterion. The results of the 20 selected Chinese learners and those of the control group are listed in Table 4.1. After selection, the correct responses ranged from 91.7 % to 100%.

**Table 4.1.** *Accuracy distribution of two groups in monosyllabic words: the number of selected subjects, mean and standard deviation*

	The number of subjects whose accuracy reaches			
	100% (24 correct)	95.8% (23 correct)	91.7% (22 correct)	Mean (sd) in %
Chinese/Taiwanese subjects (N = 20)	7	8	5	96.29 (s.d. = 3.22)
English subjects (N = 20)	10	9	1	97.70 (s.d. = 2.53)

A t-test confirmed that there was no significant difference in the accurate identification of tense and lax vowels between the selected twenty Chinese subjects and the twenty English subjects ( $t(38) = 1.54$ , n.s., two-tailed). The stress sensitivity of these twenty selected Chinese subjects was investigated in the following preference task.



### 4.2.2. Preference Task

The purpose of this task was to test the extent to which Chinese learners who had acquired the tense/lax vowel contrast preferred L2 stress patterns which followed the prediction of a proposed universal mapping between syllable structure and stress, i.e., that syllables which contain a long vowel or a coda consonant tend to be stressed. The universal mapping is tested by (i) the stressability of the final syllable of disyllabic words and (ii) the stress shift from antepenultimate to penultimate syllables in trisyllabic nouns depending on the structure of the penult.

As we have seen, final syllables are stressed in English when they contain a long vowel or a coda consonant (e.g., *agree* /ə.ɡri/ and *abash* /ə.bæʃ/) (e.g., Hammond 1999), but stress never falls on the final syllable when it only contains a lax vowel (e.g., \*/sɪ.tí/ and \*/hæ.pí/). Our first interest is to see whether the Chinese subjects are sensitive to the different stress possibilities of final syllables when they contain either a long vowel (CVV), a coda consonant (CVC) or neither (CV). Our second interest is to see if the L2 learners have acquired the stress difference in trisyllabic nouns, i.e., that when the penultimate syllable is CV, stress falls on the antepenultimate syllable (*Cá.na.da*), but when the penult contains a long vowel or a coda consonant, stress falls on the penultimate syllable (*a.ró.ma* /ə.róʊ.mə/, *a.gén.da* /ə.dʒén.də/).

In order to minimize lexical effects, we used non-words in this experiment, as in Chapter 3. However, this task differed from the preference task in Chapter 3 in three ways. Firstly, two defining factors for stress-attracting syllables were both included, i.e., vowel length and coda consonant (only coda consonants were tested in

Chapter 3). Secondly, whereas in Chapter 3 /ɪ/ was the only vowel used, in this task two pairs of vowels were used, i.e., /i/-/ɪ/ and /e/-/ɛ/. Thirdly, to minimize ambiguities that arise from orthographically represented words (consider for example, the case of *Canada-banana*), we did not present the non-words visually in this task.

Our predictions were as follows. In the disyllabic non-words which test the stress patterns of the final syllable of verbs, if the L2 learners knew the mapping between stress and syllable structure in English, they would prefer stress to fall on final syllables which consisted of CVC or CVV rather than CV. In the stress patterns of trisyllabic nouns, if the L2 learners knew the universal tendency for syllables containing a long vowel to be stressed, they would prefer penultimate stress in words with a CVVC or CVV penult. If the subjects were aware of the universal tendency for syllables containing a coda consonant to be stressed, they would prefer penultimate stress in words with CVC and CVVC penults. If they were sensitive to both of these factors, they would prefer penultimate stress when the penults are CVVC, CVC or CVV, and in all cases, they would show a preference for CV penults to be unstressed.

#### **4.2.2.1. Materials**

##### ***4.2.2.1.1. Non-words Targeting the Stressability of the Final Syllable of Disyllabic Verbs***

Thirty-two pairs of disyllabic non-words were created with differing final syllable structures. There were three types of final syllable: CV (short), CVV (long vowel), and CVC (closed). For each syllable type, half the syllables contained the high vowels /ɪ/ and /i/ and the other half contained the mid vowels /ɛ/ and /e/. All the

items had stress on the final syllable. Each pair of test items consisted of one non-word whose stressed final syllable was of the CV type (e.g. /kə.tí/) and one non-word whose stressed final syllable was either CVC (e.g., /kə.tík/) or CVV (e.g., /kə.tí/). Sixteen pairs contrasted CVV vs. CV, e.g., /kə.tí/ vs. /kə.tí/, and the other sixteen pairs contrasted CVC and CV, e.g., /ləkév/ vs. /ləké/. Since final stress in English occurs mostly in verbs, the stimulus words were presented as verbs in a carrier sentence frame, e.g., *We often \_\_\_\_\_ them.* All the test words are given in Appendix 4.

#### 4.2.2.1.2. *Non-words Targeting the Stress Difference in Trisyllabic Nouns*

There were sixty-four pairs of trisyllabic non-words. The design of the trisyllabic non-words was very similar to those in the experiment in Chapter 3 except for the increased number of vowel types: whereas only the vowel /ɪ/ was used in Chapter 3, the four vowels /ɪ/, /ɛ/, /i/ and /e/ were used in this task. In each pair of sound stimuli one item had antepenultimate stress and the other had penultimate stress, e.g., /ná.tim.pə/ and /nə.tim.pə/. There were four types of penultimate syllable: (i) open with a short nucleus (CV), e.g., /sé.bɪ.kər/ vs. /sə.bɪ.kər/, (ii) open with a long nucleus (CVV), e.g., /dé.zi.təs/ vs. /də.zi.təs/, (iii) closed with a short nucleus (CVC), e.g., /bén.fɪm.pəs/ vs. /bən.fɪm.pəs/, and (iv) closed with a long nucleus (CVVC), e.g., /ná.tim.pə/ vs. /nə.tim.pə/. There were 16 pairs for each syllable type. Half of the lax vowels in the CV and CVC penultimate syllables were /ɪ/ and the other half were /ɛ/. Correspondingly, half of the tense vowels in CVV and CVVC penultimate syllables

were /i/ and the other half were /e/. These words were embedded in carrier sentences as nouns. The full list of test items is provided in Appendix 4.

The resulting ninety-six pairs of non-words with two or three syllables in carrier sentences were pre-recorded in a sound recording studio by the same speaker as in the screening test. The recording procedure used was the same in Chapter 3: the speaker practiced reading the lists of sentences out loud at a comfortable rate and spacing the sentences equally. The block elicitation method was used again so that the speaker would be able to maintain the same rhythmic pattern and segmental quality across comparable items: the sentences were first recorded in a block of initial stress items and then in a block with final stress, then, after a break, the sentences were recorded in a pair-by-pair fashion. Additional repetitions were allowed when the speaker felt dissatisfied with a recording. The productions were recorded on DAT. The sentences from the last repetition of the second block were used for the stimuli. The recordings were digitized at 22.05 kHz (16 bit) on a personal computer.

#### **4.2.2.2. Subjects**

The subjects for the preference task consisted of the 20 Chinese learners who passed the screening test described above and the same 20 native speakers of English as described above.

#### **4.2.2.3. Procedure**

All of the 96 pairs of digitized sound files were programmed in E-prime. In each trial, the carrier sentence appeared on the screen for 2000 msec, followed by two sound



stimuli with an interval of 500 msec in between, each with a different pronunciation of the non-word in terms of syllable structure in disyllabic verbs and stress placement in trisyllabic nouns. Five pairs of practice items were presented prior to the test. The presentation order of the 96 test items was randomised for each subject.

Subjects were tested individually in the same sound-insulated booth where they took the screening test (described above). For this test the keys were labelled as '1' and '2', where '1' indicated the first sound stimulus and '2' the second sound stimulus. First the participants saw the visual stimulus e.g., *The \_\_\_\_\_ is white*, where the blank indicated the non-word (the non-word was not visually presented). They then heard two sentences one after the other, e.g., "*The /nætɪmpəl/ is white. The /nætɪmpəl/ is white*," and pressed a key to indicate which of the non-words sounded more natural as a potential English word. There was an interval of 1000 msec between each trial, calculated from the point when the key was pressed from the previous trial. When in doubt the participant was asked to guess. No replay was permitted. There was a practice session with 5 pairs of sound stimuli. Each of the participants was paid £3 for their participation in the experiment.

#### **4.2.2.4. Results and Discussion**

##### **4.2.2.4.1. Preference for Final Stress in Disyllabic Verbs**

Table 4.2 presents the results of subjects' preference for final stress in  $\sigma$ .CVV words (e.g., /kəti/) and  $\sigma$ .CVC words (e.g., /səlɪg/) over final stress in  $\sigma$ .CV words (e.g., /kəti/ and /səlɪ/).



**Table 4.2.** Means and standard deviations of stress preferences for final stress when the final syllable is CVV or CVC opposed to CV

	<b>Tense CVV (16 items)</b> <b>Mean (s.d.) in %</b>	<b>Closed CVC (16 items)</b> <b>Mean (s.d.) in %</b>
Native speakers of English (N = 20)	/i/ 85.63 (12.04)	/I/ 87.50 (17.90)
	/e/ 86.88 (19.15)	/ε/ 86.30 (11.80)
Total	86.25 (12.43)	86.88 (8.13)
Chinese learners of English (N = 20)	/i/ 77.50 (17.05)	/I/ 84.40 (14.70)
	/e/ 85.00 (12.87)	/ε/ 88.80 (11.80)
Total	81.25 (12.34)	86.25 (9.60)

Both English and Chinese subjects showed an overwhelming preference for stressed CVV syllables, i.e., over 80%. This suggests that stressed CVV syllables are preferred over stressed CV syllables. A repeated measures ANOVA was run to examine whether the Chinese subjects' preference for stressed C/i/ and C/e/ is different from the English subjects. There was no significant main effect of either VOWEL TYPE [ $F(1,38) = 1.078$ ;  $p = 0.306$ ] or FIRST LANGUAGE [ $F(1,38) = 1.547$ ;  $p = 0.221$ ], and not was there an interaction between VOWEL TYPE and FIRST LANGUAGE [ $F(1,38) = 0.000$ ;  $p = 1.000$ ]. These results show that the two groups do not differ in their preference for the stressed final CVV syllables, nor do they show any preference for one vowel over the other (/i/ and /e/).

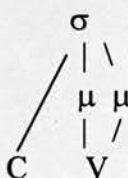
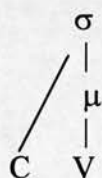
Similar to the result of the CVV-CV paired test above, both English and Chinese subjects show an overwhelming preference for the stressed CVC syllables (over 85%), which already suggests that stressed CVC syllables were preferred over stressed CV syllables. A repeated measures ANOVA was run to examine whether the Chinese subjects' preference for stressed C/iC and C/eC is different from the English subjects. There were no significant main effects for either VOWEL TYPE [ $F(1,38) = 1.169$ ;  $p = 0.286$ ] or FIRST LANGUAGE [ $F(1,38) = 0.047$ ;  $p = 0.830$ ], and nor was

there an interaction between VOWEL TYPE and FIRST LANGUAGE [ $F(1,38) = 0.292$ ;  $p = 0.592$ ]. These results provide no evidence of a difference between the two groups for CV vs. CVC, nor between the vowels /ɪ/ and /ɛ/.

The results robustly show that these learners preferred CVV and CVC syllables be stressed rather than CV syllables. This suggests that they were aware that lax vowels (CV) are disfavoured in the mapping with stress, and that long vowels (CVV) and lax vowels followed by coda consonants (CVC) do tend to map with stress. In the metrical analysis, this indicates that they know (i) the weight difference between lax vowels (CV) and tense vowels (CVV), and (ii) the weight difference between open short syllables (CV) and closed syllables (CVC). In terms of moraic theory, they appeared to treat CV as mono-moraic (and light) and CVV and CVC as bimoraic (heavy), as shown in (4.1).

(4.1) *Weight-stress mapping in Chinese learners of English in this task*

a. lax vowel = unstressed    b. tense vowel = stressed    c. closed = stressed



However, although it is possible to account for the Chinese subjects' stress preference in terms of the metrical weight-stress mapping, there is an alternative explanation based on English phonotactic constraints. The occurrence of lax vowels in English can be predicted according to their position within a word. It is a distributional fact that lax vowels cannot occur word-finally (e.g., Giegerich, 1992;

Hammond, 1999). Therefore, it is very possible that the knowledge of English phonotactic restrictions is already sufficient for subjects to be aware that such words do not exist, and to dislike the non-words which end in a lax vowel (i.e., prefer those which end in its tense counterpart). It is therefore still not clear whether in this task the L2 learners (and even the native speakers of English) employed their abstract knowledge of the mapping between syllable structures and stress, or whether they were simply using the distributional information relating to English phonotactic restrictions from the input.

Because the stress mapping account coincides with the phonotactic account on this point, we proceed to examine the data from trisyllabic non-words in order to seek further evidence of the L2 learners' knowledge of the mapping between stress and syllable structure.

#### **4.2.2.4.2. Stress Preferences for Trisyllabic Nouns**

The same subjects also performed the stress preference task with trisyllabic nouns with a penult consisting of either CVVC, CVC, CVV or CV. Each word had two stress patterns, i.e., antepenultimate stress and penultimate stress. The task was to judge which word sounded more likely to be a potential English word (e.g., /bə'sɪlkə/ vs. /bəsɪlkə/). Table 4.3 below shows the subjects' preference for stress on penultimate syllables as opposed to antepenultimate syllables, depending on the structure of the penult.

**Table 4.3.** *Preferences for penultimate stress in trisyllabic non-words, according to penult type*

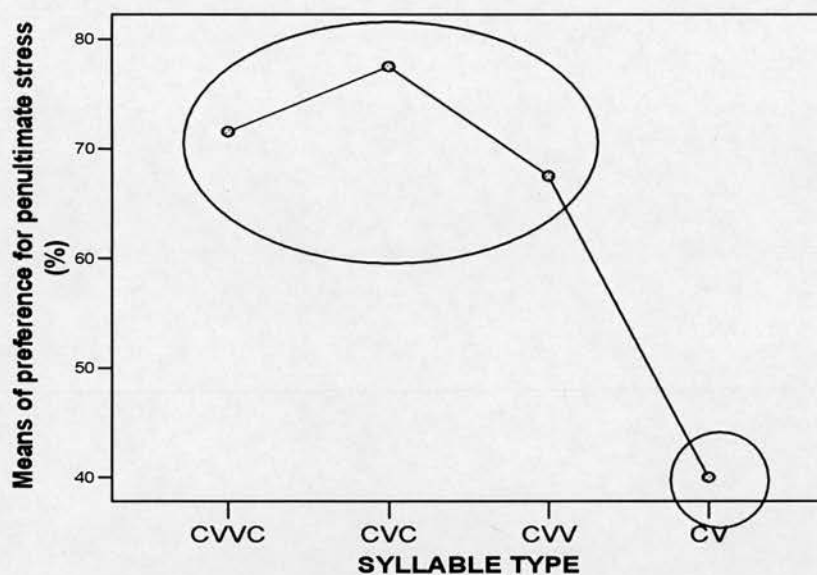
	<b>CVVC</b> Mean (s.d.) in %	<b>CVC</b> Mean (s.d.) in %	<b>CVV</b> Mean (s.d.) in %	<b>CV</b> Mean (s.d.) in %
Native speakers of English (N = 20)	71.56 (10.23)	77.50 (14.53)	67.50 (13.39)	40.00 (14.39)
Chinese learners of English (N = 20)	71.56 (16.16)	69.38 (17.54)	50.00 (15.84)	29.69 (11.45)

A repeated measures ANOVA showed that there were significant main effects for both SYLLABLE TYPE [ $F(3, 114) = 58.11$ ;  $p < 0.01$ ] and FIRST LANGUAGE [ $F(1,38) = 18.55$ ;  $p < 0.001$ ]. There was no interaction [ $F(3,114) = 2.39$ ; n.s.]. This shows that the structure of the penultimate syllable did affect subjects' preference for penultimate stress in both of the groups. In addition, the subjects' L1 also affected their performance. Nevertheless, the lack of interaction between the two factors showed that overall the two groups had a similar tendency in their preference for penultimate stress in the four types of syllable structures.

In the group of native English speakers, a repeated measures ANOVA showed that the type of syllable structure did affect the preference for penultimate stress [ $F(3,57) = 36.68$ ;  $p < 0.01$ ]. Pairwise comparisons using Bonferroni's post hoc test showed two subsets: (a) some subjects preferred penultimate stress when the penult was CVVC, CVV or CVC, and (b) some preferred antepenultimate stress when the penult was CV. In general, the preference hierarchy was CVVC, CVC, CVV >> CV, where ">>" indicates "is preferred to", as shown in Figure 4.1.



**Figure 4.1.** *Preference shown by native speakers of English for stress on penults depending on which of the four structure types it had (CVVC, CVC, CVV, CV)*



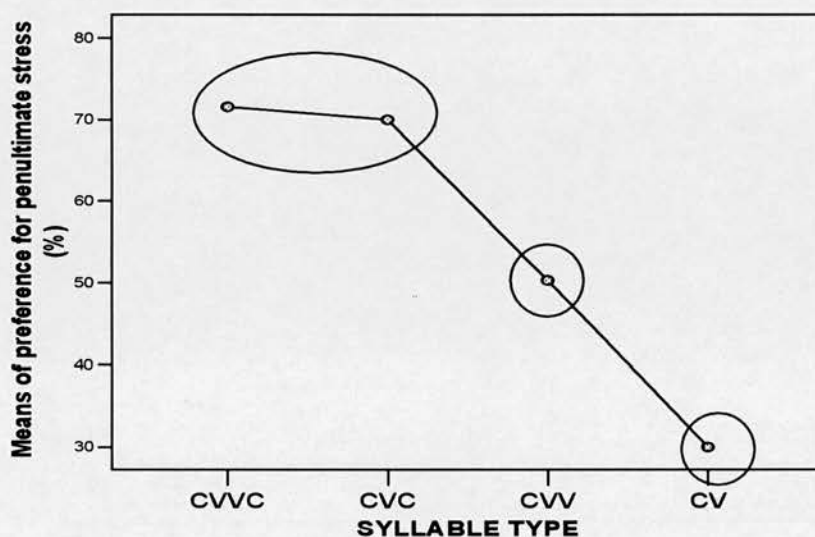
From these results from the native English subjects, we are able to conclude confidently that the non-words in this experiment complied with the generalizations for English stress provided in the theoretical literature, and therefore, that they constitute a baseline with which to compare the results of our L2 learners.

For the Chinese learners, a repeated measures ANOVA showed that the type of syllable structure did affect the preference for penultimate stress [ $F(3,57) = 26.85$ ;  $p < 0.01$ ]. Pairwise comparisons using Bonferroni's post hoc test showed three subsets: (a) CVVC, CVC, (b) CVV, and (c) CV. In the open syllables, like the native speakers of English, the learners preferred penultimate stress when the penult contained a long vowel (CVV) but antepenultimate stress when the penult contained only a lax vowel (CV). This indicated that they knew the mapping between stress and the vowel type. Furthermore, this also indicated that, as was the case with open tense



vowels, these learners also preferred penultimate stress for closed syllables (CVVC and CVC). It is also interesting that they showed different degrees of preference for closed syllables (CVVC and CVC) and open syllables (CVV), something which was not found in native speakers of English, and which formed a three-level stress hierarchy CVVC, CVC >> CVV >> CV for these subjects, as shown in Figure 4.2.

**Figure 4.2.** *Chinese learners' preferences for stress on the penult depending on which of the four structure types it had (CVVC, CVC, CVV, CV)*



In line with our findings for disyllabic verbs (above), the Chinese learners showed a preference for penultimate stress when the syllable was CVV, CVC or CVVC. They were aware that CV tended not to be mapped with stress, as distinct from CVV, CVC and CVVC. However, unlike the English control subjects, they also favoured CVC and CVVC over CVV as stressed syllables. This shows that in addition to following the general mapping between stress and syllable structure, they had a stronger tendency to assign stress to closed syllables. Although this result is not identical to

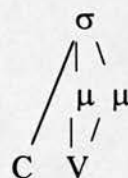
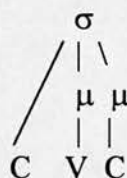
that of English natives, it is systematic in terms of the learners' L1 phonological structure. Specifically, closed syllables in Chinese always bear full tone and are said to have two moras, while open syllables can have either a full tone or a neutral tone and can be either bimoraic ("heavy") or mono-moraic ("light") (as reviewed in Section 2.4). This makes it appear that L1 effects may be overlaid on the general pattern of the mapping between stress and syllable structure. However, another possibility is that Chinese subjects were not as sensitive to the mapping between stress and long vowels as they were to the mapping between stress and coda consonants. In fact, we will go on to show that the second of these alternatives has more support. We therefore draw the interim conclusion that (i) Chinese learners are sensitive to the mapping between stress and syllables with a long vowel or a coda consonant, and (ii) Chinese subjects have a stronger stress preference for closed syllables than open syllables with a long vowel.

These results can be analysed from the metrical theory point of view. In the metrical analysis, the prosodic structures underlying such stress mapping with various types of syllable structure are shown in the following diagram.

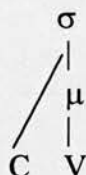
(4.2) *Weight-stress mapping in Chinese learners of English, proposed on the basis of results from trisyllabic nouns*

a. closed = stress-attracting

b. long = stress-attracting



c. short = non-stress-attracting



Since these Chinese subjects were able to distinguish the tense and lax vowels in the screening test and since they preferred penultimate stress for CVV over CV in this task, tense vowels can be analyzed as bimoraic, as shown in (4.2 b), and lax vowels as mono-moraic (4.2 c). Moreover, since these Chinese subjects preferred penultimate stress for CVC rather than CV in this task, coda consonants are taken to be mora-projecting so that CVC is bimoraic, as shown in (4.2a). Because CVVC contains both a long vowel and a coda consonant, it was preferred as stress-attracting.

In the non-metrical analysis, on the other hand, there is no notion of syllable weight. It can be said instead that these learners simply make a generalization such as, “when the penultimate syllable contains a long vowel or a coda consonant, then penultimate stress is chosen; when the penultimate syllable contains none of them, then antepenultimate stress is chosen.” In this case, the analysis is more likely to be the one presented previously in (2.20) of Section 2.1.1.2. These two analyses will be discussed further in Chapter 5.

The analyses provided so far have been based on the behaviour of all 20 learners, but there are also valuable insights to be gained from examining the individual differences which were observed. Logically speaking, there were five possible results from the two factors, coda consonants and long vowels, in relation to stress: a) sensitivity to none of them i.e., no difference of means in four syllable types, b) sensitivity to coda consonants only i.e., treating CVVC and CVC as heavy but CVV and CV as light, c) sensitivity to long vowels only i.e., treating CVVC and CVV as heavy and CVC and CV as light, and d) sensitivity to both coda consonants and long vowels without a cumulative effect i.e., treating CVVC, CVC and CVV as heavy and CV as light, and e) sensitivity to both factors plus a cumulative effect i.e., treating CVVC, CVC and CVV as heavy, CV as light, and CVVC as being heavier than CVC and CVV.

Univariate analyses were undertaken to see whether each subject's stress preferences in four types of syllables were different or not. Table 4.4 shows the patterns attested, the number of subjects showing that pattern, and the statistical reports for all subjects. The array mark (>>) in the leftmost column indicates that subjects' preference for penultimate stress in one syllable type was found to be significantly different from the other type. The equals sign (=) indicates that no significant difference of preference for penultimate stress between syllable types is found. Multiple comparisons using Bonferroni's post hoc test were carried out in order to see whether each subject's stress preferences in four types of syllables are different from each other. For example, Pattern (2a) means that both CVVC and CVC penults were preferred to bear stress over CVV and CV; however, no

difference was found between CVVC and CVC, nor between CVV and CV. Four subjects' performance showed this pattern, as shown in the middle column.

**Table 4.4.** *Patterns of stress preference by the 20 Chinese subjects*

Pattern of stress preferences	Number of subjects exhibiting pattern	ANOVA report for each subject
No pattern: No dominance relationship in four syllable types	5	Subject 16: $F(3, 60) = 0.43$ ; n.s. Subject 19: $F(3, 60) = 0.39$ ; n.s. Subject 31: $F(3, 60) = 1.97$ ; n.s. Subject 112: $F(3, 60) = 0.90$ ; n.s. Subject 135: $F(3, 60) = 0.65$ ; n.s.
Pattern 1 a. CVVC=CVC>>CVV=CV	4	Subject 11: $F(3, 60) = 10.72$ ; $p = 0.000$ Subject 13: $F(3, 60) = 7.14$ ; $p = 0.000$ Subject 134: $F(3, 60) = 10.36$ ; $p = 0.000$ Subject 140: $F(3, 60) = 4.95$ ; $p = 0.004$
b. CVVC=CVC=CVV>>CVV=CV	2	Subject 22: $F(3, 60) = 5.00$ ; $p = 0.004$ Subject 104: $F(3, 60) = 5.35$ ; $p = 0.002$
c. CVVC=CVC>>CVC=CVV=CV	1	Subject 17: $F(3, 60) = 5.20$ ; $p = 0.003$
d. CVC=CVVC=CVV>>CVVC=CVV=CV	1	Subject 143: $F(3, 60) = 6.15$ ; $p = 0.009$
Pattern 2 a. CVVC=CVV>>CVC=CV	2	Subject 30: $F(3, 60) = 4.95$ ; $p = 0.004$ Subject 145: $F(3, 60) = 4.95$ ; $p = 0.004$
b. CVVC=CVV=CVC>>CVC=CV	1	Subject 124: $F(3, 60) = 4.95$ ; $p = 0.004$
Pattern 3: CVVC=CVV=CVC>>CV	3	Subject 101: $F(3, 60) = 8.40$ ; $p = 0.000$ Subject 110: $F(3, 60) = 4.95$ ; $p = 0.000$ Subject 131: $F(3, 60) = 4.95$ ; $p = 0.000$
Pattern 4: CVVC>>CVC=CVV>>CV	1	Subject 146: $F(3, 60) = 11.12$ ; $p = 0.000$

Five out of the 20 subjects did not show significant mean differences in their preference for penultimate stress in the four syllable types, as shown in the second row of Table 4.4 (i.e., No pattern). These five subjects showed no sensitivity to the



relationship between syllable structure and stress placement in English penultimate syllables. This suggests that although these five subjects have acquired the contrast between long and short vowels at the segmental level (as demonstrated in their native-like performance in the screening test), they have not acquired either the mapping between stress and syllables with a long vowel (i.e., tense vowels tend to be stressed while lax vowels tend not to be) or the mapping between stress and syllables with a coda consonant (i.e., syllables containing a coda consonant tend to be stressed). In other words, the segmental contrasts of the vowels had been acquired while the stress mapping of the vowels had not.

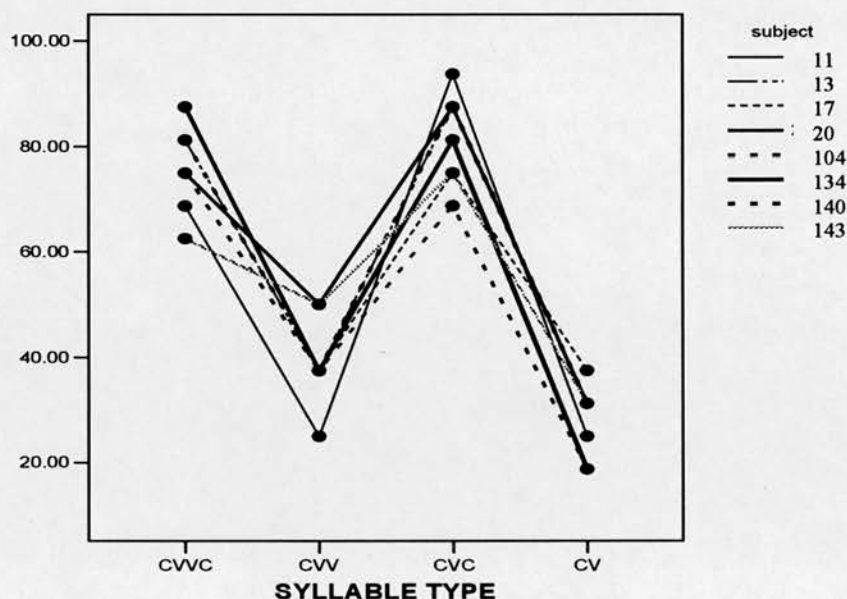
The other fifteen subjects showed significant mean differences in their stress preferences for different types of penultimate syllables to some extent. A common feature shared by all 15 subjects was that stressed CVs were never preferred over the other three structures (CVVC, CVV and CVC). In other words, CV always attracted stress less than the others, following the universal of quantity-sensitive languages. However, other aspects of the preference pattern differed within this group. Four patterns of preference can be identified.

The first of these (Pattern 1 in Table 4.4) is characterized by a preference for closed syllables to be stressed. This general preference can be divided into four sub-patterns. In the first sub-pattern (Pattern 1a), both CVVC and CVC are more stress-attracting than CVV and CV. The mean of CVVC was not different from CVC and the mean of CVV was not different from CV, but the means of CVVC and CVC were both different from those of CVV and CV. Their stress preference clearly relied on the closed/open difference of the penultimate syllable: if it was closed, then stress was attracted to the penultimate syllable; if it was open, stress was not attracted onto

the penult. Since there was no difference between CVVC and CVC and no difference between CVV and CV, the cue of vowel length does not appear to have been used in their preference decision. The second sub-pattern (1b) differs from (1a) in that the status of CVV is not significantly different from that of the other three syllable types. That is, the closed syllables CVVC and CVC are stress-attracting in contrast to open syllables with a short vowel (CV), while the open syllables with a long vowel (CVV) were sometimes preferred to be stress-attracting but sometimes not. The subjects who showed this preference appear to rely mainly on the cue of coda consonant in stress assignment, rather than the cue of vowel length. In the third sub-pattern (1c), CVVC was preferred to be stress-attracting 87.5% of the time, which was significantly different from CVV (37.5%) and CV (37.5%), while CVC (75%) was also preferred to be stress-attracting but the preference was not statistically different from CVV and CV. This sub-pattern can therefore be classified as the cue of coda consonants being more important than the cue of vowel length. The fourth sub-pattern (1d) indicated that CVC was preferred to be stress-attracting 75% of the time, which was significantly different from CV (31.3%). The main factor in this difference was also the coda consonant. However, the stress status of CVVC (62.5%) and CVV (50%) was not significantly different from the stressed CVC and the unstressed CV. Guion, Harada, and Clark (2004) suggest that non-natives' stress preferences for non-words may be affected by other factors like phonological similarity and lexical frequencies to some extent. In this sense, there may be some other factors other than syllable structure influencing their preference judgment which must remain unidentified here. Nevertheless, the pattern this subject showed was also one where the cue of coda consonant was dominant. In total, there are 8

subjects whose performance shows this main pattern i.e., reliance on the coda consonant cue. A graph of this is shown below.

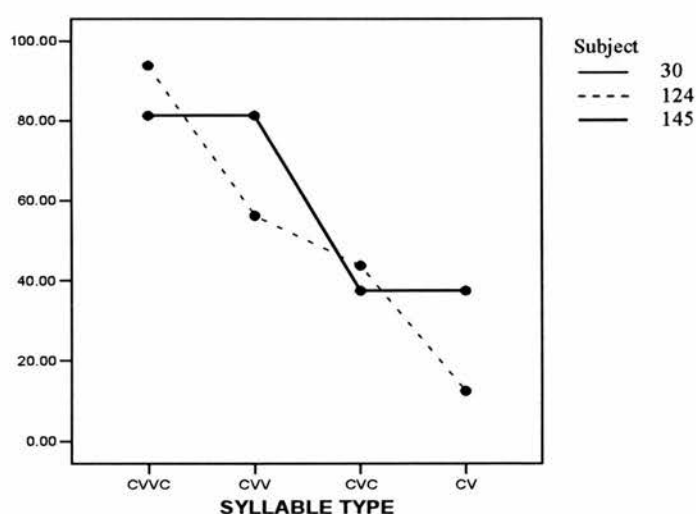
**Figure 4.3.** *By-subject analysis of the preference for penultimate stress in four types of penultimate syllable structure (Pattern 1)*



Pattern 2 can best be described as one where the dominant cue is vowel length rather than coda consonant. In the first sub-pattern (Pattern 2a), both CVVC and CVV were stress-attracting rather than CVC and CV, according to the multiple comparisons, which also showed that the mean of CVVC was not different from CVV and the mean of CVC was not different from CV, but the means of CVVC and CVV were both different from those of CVC and CV. Their stress preference was therefore dependent on the long/short vowel difference, i.e., if the vowel was long (CVVC, CVV), then the penultimate syllable was stressed; if not (CVC, CV), then the antepenultimate syllable was stressed. Because there was no difference between

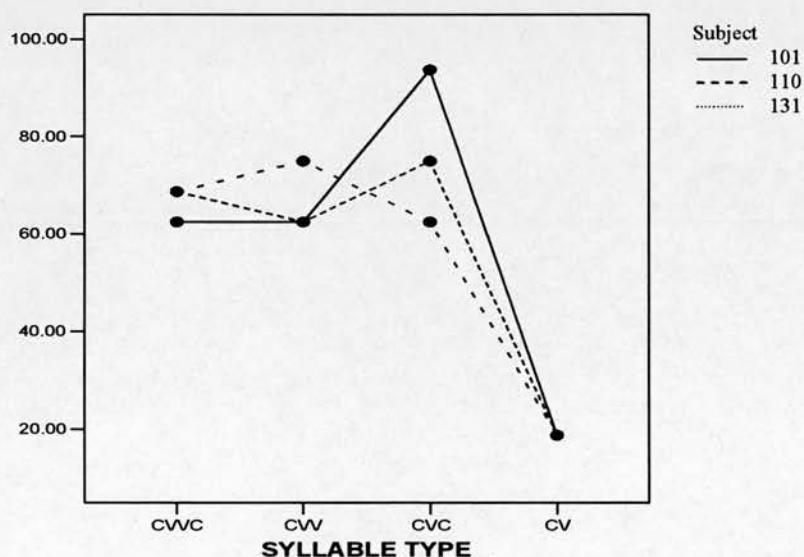
CVVC and CVV and between CVC and CV, the learners may not be using the cue of coda consonants properly in their preference decision. There were two subjects who showed this sub-pattern. The sub-pattern (2b) differs from (2a) in that the status of CVC was not significantly different from that of with the other three syllable types. Syllables with a long vowel were stress-attracting in contrast with syllables containing a short vowel (CV), while CVC was sometimes preferred to be stress-bearing but sometimes not. We suggest that this sub-pattern indicates a reliance on the cue of vowel length with concomitant exploitation of the coda consonant cue. Only one subject showed this sub-pattern. In total, there were 3 subjects who relied on the cue of vowel length rather than that of coda consonant in determining the penultimate/antepenultimate stress preference in trisyllabic nouns, as shown in the following graph. (Two subjects had identical performance, so only two lines can be seen in the graph.)

**Figure 4.4.** *By-subject analysis of the preference for penultimate stress in four types of penultimate syllable structure (Pattern 2)*



In Pattern 3, the three structures CVVC, CVV and CVC did not differ from each other, but were preferred to be stress-attracting in a significantly different way from CV. Subjects who exhibited this pattern seem to have been sensitive to both of the cues, vowel length and coda consonant, but their stress preference relied on only one of the cues, not both. Therefore, CVVC (with both a long vowel and a coda consonant) is not treated as heavier than CVV (with a long vowel) or CVC (with a coda consonant). This pattern is in fact close to the English subjects' pattern, as presented in Figure 4.5. There were three subjects who exhibited this pattern, as shown in the following graph.

**Figure 4.5.** *By-subject analysis of the preference for penultimate stress in four types of penultimate syllable structure (Pattern 3)*

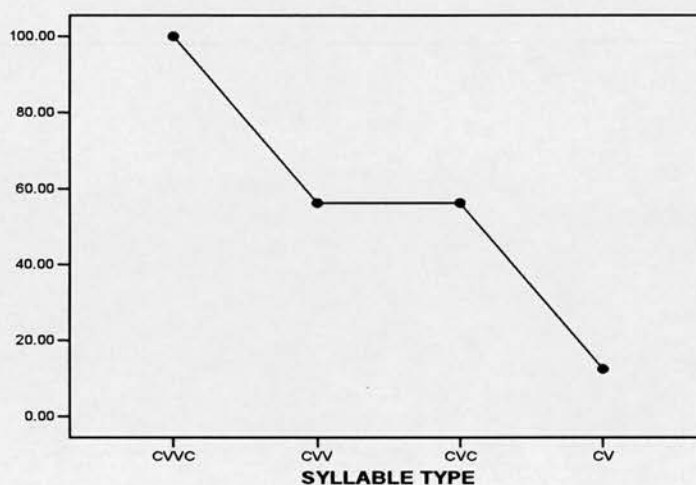


Finally, in Pattern 4, CVVC, CVV and CVC were preferred to be stress-attracting rather than CV, which implies sensitivity to both of the cues. However,



unlike in Pattern 3, the two factors are cumulative here, so that CVVC was preferred to be stress-attracting even more than CVV and CVC. The stress preference hierarchy is a three-layered one, i.e., CVVC is superheavy, CVV and CVC are heavy and CV is light. Only one subject showed this pattern, as shown in following graph.

**Figure 4.6.** *By-subject analysis of the preference for penultimate stress in four types of penultimate syllable structure (Pattern 4)*



The instantiations of these different patterns show that although the group of Chinese subjects as a whole are sensitive to the mapping between stress and syllable structure, and have a stronger tendency to stress closed syllables than open syllables, nevertheless there are several individual differences.

To summarize, those Chinese speakers of English who could identify lax-tense vowels in English as successfully as native speakers of English also seemed to be aware of the mapping between stress and syllable structure. That is, according to the results of the preference task for disyllabic items, they appeared to realize that CV tends not to be stressed, but that CVV and CVC do tend to be stressed. Secondly,

according to the preference task with trisyllabic nouns, 75% of these Chinese subjects also showed sensitivity to the mapping between stress and syllable structure when the syllables are closed or contain a long vowel. Furthermore, four different patterns were detected in this study (excluding 25% of the Chinese subjects who were sensitive to neither vowel length nor coda consonants): 1) 40% of them ( $n = 8$ ) are sensitive to coda consonants but not to vowel length; 2) 15% of them ( $n = 3$ ) are sensitive to vowel length but not to coda consonant; 3) 15% of them ( $n = 3$ ) show near native-like sensitivity to both vowel length and coda consonants, and (4) 5% of them ( $n = 1$ ) show sensitivity to cumulative effects of both vowel length and coda consonants, even though, interestingly, the superheavy CVVC implied by the cumulative effect from both factors does not exist in English mono-morphemic words.

An interesting finding from the analysis of the Chinese groups is that these learners were less sensitive to the mapping between stress and syllables with a long vowel in trisyllabic nouns compared to the mapping between stress and syllables closed by a coda consonant. A similar result is also found in the by-subject analysis, i.e., over half of the 15 subjects show stress sensitivity to the mapping between stress and syllables which contain a coda consonant but not those which contain a long vowel. One question that arises from these findings is what factors might lead to this relative lack of sensitivity to long vowels and their mapping with stress. According to the literature on the acquisition of L2 vowels, it is widely reported that native-like perception of vowels is almost impossible to acquire even for very advanced learners (Flege, Bohn, & Jang, 1997; Flege & MacKay, 2004; Flege, MacKay, & Meador, 1999). This difficulty also occurs in Chinese learners of English (Wang, 2002; Wang

& Munro, 1999). Although the screening test showed that our subjects could generally perceive tense vowels in the monosyllabic words just as successfully as the English native speakers, it may be that their perception of L2 English vowels becomes unstable when the complexity of phonological structures increases (e.g., from monosyllabic to di- or multi-syllabic words). This might have consequences for their sensitivity to the stress mapping conditioned by vowels. In order to test this hypothesis, another vowel identification task was conducted with the same subjects.

### **4.2.3. Vowel Identification Task**

#### **4.2.3.1. Materials**

The design and procedure were the same as the screening test except that the words used were all disyllabic (e.g., *bitter-beater*), as presented in Appendix 5. Twelve pairs of filler items with other segmental contrasts were also included.

#### **4.2.3.2. Subjects**

The 20 Chinese subjects who passed the screening test and participated in the preference task formed the experimental group. The same twenty English subjects in the screening test and the preference task also participated as the control group.

#### **4.2.3.3. Procedure**

All of the 24 digitized files of target words plus 12 filler items were programmed in E-prime. In each trial, the orthographic stimuli of the word pairs like *bitter-beater* were displayed visually on the screen, and then the sound stimuli of one of the two

words, e.g., /bítər/, was played auditorily to the subjects. The 36 test items were presented in random order.

As before, subjects were tested individually in a sound-insulated booth, which had a desktop computer, a set of high quality headphones and an input keyboard. Two keys were labelled as 'Left' and 'Right'. Subjects were told that they were going to see two words and then hear one sound in each trial. Their task was to determine which word matched the sound they heard by pressing the appropriate key. Each trial after the first started 1000 msec after their response to the previous stimulus. The subject was asked to guess when in doubt. A practice session with 5 pairs of words was provided before the experimental trials.

#### **4.2.3.4. Results and Discussion**

As predicted, Chinese subjects performed worse in the vowel identification of disyllabic word pairs. Accurate identification of vowels in the control group was again generally high, ranging from 91.7% (22 correct out of 24) to 100% (24 correct out of 24). On the other hand, the performance of the 20 Chinese subjects was not as homogeneous as in the screening test (where they identified vowels in monosyllabic word pairs). Their responses ranged from 66.7 % correct (16 out of 24) to 95.8% (23 out of 24), indicating that some of them could not distinguish the tense/lax vowels of disyllabic words in a native-like way.



**Table 4.5.** *Accuracy distribution of both groups in disyllabic words*

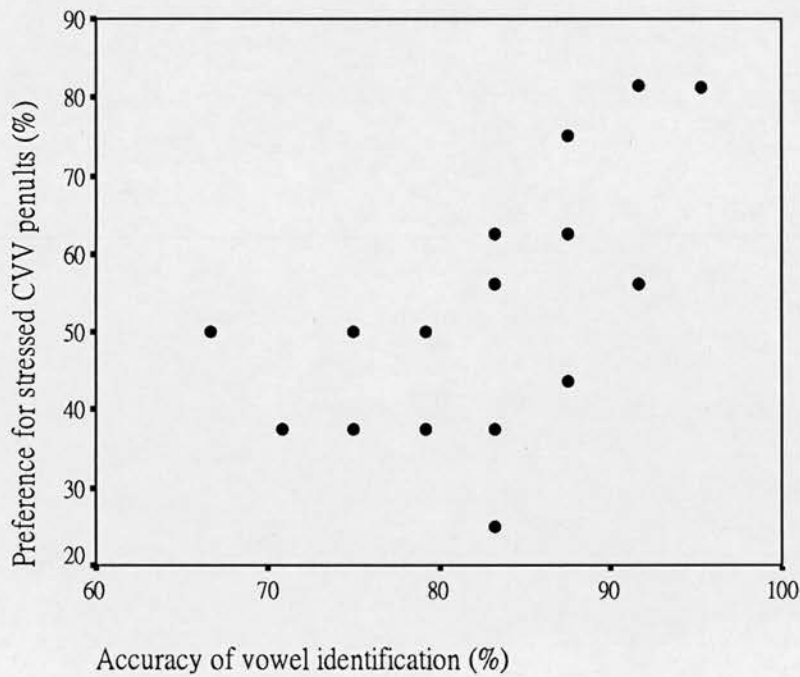
(Number correct)	Number of subjects at different accuracy levels									
	100% (24)	95.8% (23)	91.7% (22)	87.5% (21)	83.3% (20)	79.2% (19)	75% (18)	70.8% (17)	66.7% (16)	
Chinese subjects	0	1	2	3	4	3	3	2	1	Mean = 81.7% s.d. = 7.8%
English subjects	10	9	1							Mean = 98.0% s.d. = 2.1%

Although these L2 subjects could perceive tense and lax vowels very successfully in the monosyllabic words, and although some of them were also aware of the stress distinction between tense and lax vowels (since they generally disfavoured stressing lax vowels), the accuracy of their perception of the two types of vowels decreased in disyllabic words. The increased phonological complexity (e.g., the contrast between a stressed syllable followed by an unstressed syllable) seems to have reduced their accuracy in identifying vowels in this task. This may account for why the L2 learners were less sensitive to the mapping between stress and long vowels – because they do not perceive these two types of vowels in multisyllabic words as successfully as they did in monosyllabic words. So even if these learners had acquired the segmental contrasts of vowels in monosyllabic words such as *beat-bit*, this does not guarantee that the same contrast has been acquired in a more complex context such as when they are mapped with stress. Furthermore, a positive correlation was found between these L2 learners' sensitivity to the CVV-stress mapping and their vowel identification of disyllabic words ( $r = 0.635$ ;  $n = 20$ ;  $p < 0.001$ ) (see Figure 4.7 below). This suggests that the learners' sensitivity to the mapping between stress and syllables containing a long vowel is conditioned by their ability to accurately identify L2 vowels in multisyllabic words. At the same time,



this also suggests that those who can identify the relevant vowels already know the consequences of vowel type for stress assignment.

**Figure 4.7.** *L2 subjects' sensitivity to the CVV penult and accuracy of vowel identification in disyllabic words*



**4.3. General Discussion**

In the series of experiments presented in this chapter, we found some important results with respect to word stress acquisition by Chinese learners of English. Our findings challenge Archibald's view that the acquisition of stress by tone language speaking learners of English is not related to phonological structures. In Chapter 3 we presented evidence that at least some Chinese speakers systematically show sensitivity to the stress contrast between CV and CVC penults, and that their tendency to assign stress to CVC penults was stronger when the coda consonant was a sonorant rather than an obstruent. This pattern can be interpreted either as an effect

of Chinese syllable structure (i.e., the lack of obstruent codas) or as a universal weight-to-stress interaction (i.e., sonorant codas contribute more to weight than do obstruent codas). In this chapter, we further presented evidence for an L2 pattern that is consistent with the universal mapping between stress and syllable structure. The group of Chinese learners who had acquired the tense/lax vowel distinction in English showed a systematic preference for stress on syllables which contained either a long vowel or a coda consonant, even though these learners' L1 does not have lexical stress. Interestingly, the general pattern was overlaid with effects from their L1, i.e., closed syllables tend to be stressed more, arguably because the lack of a contrast between tense and lax vowels in Mandarin Chinese affects these L2 learners' ability to map stress with long vowels. Although several different patterns were attested when the data were analyzed on an individual basis, all the participants followed patterns that are sanctioned by the universal mapping between stress and syllable structure, including a native-like pattern (preference for stress to occur on penultimate syllables which contain either a long vowel or a coda consonant, e.g., /dəzítəs/ and /bənˈfɪmpəs/ but /séɪkər/) and two non-native-like patterns, including (i) preference for stress to occur on the penultimate syllable when it contains a long vowel but not a coda consonant (e.g., /dəzítəs/ but /bénˈfɪmpəs/ and /séɪkər/) and (ii) preference for the penultimate syllable to be stressed when it contains a coda consonant but not a long vowel (e.g., /bənˈfɪmpəs/ but /dézítəs/ and /séɪkər/. One of the non-native-like patterns (i.e., preference for penultimate stress when the penult contains a long vowel but not when it contains a coda consonant) has been explained from the perspective of the fragility of L2 vowels, while discussion of the other patterns is deferred until the next chapter.

Since almost all of these L2 stress patterns are permitted by the universal mapping between stress and syllable structure (a type of phonological universal), the question that now arises is where these L2 learners' knowledge about the general mapping between stress and syllable structure comes from: perhaps it is related to a pattern inherent in Mandarin Chinese, or it could come from a constraint in UG, or it could simply be a reflection of the surface patterns observable in English. Let us consider the first possibility that the L2 learners carried over the WSP from Chinese. As mentioned in Section 2.4, there are two types of syllable structure in Chinese: "heavy" when the syllable has a full tone and "light" when the syllable has neutral tone. Yip (2002) explicitly argues that the Weight-to-Stress Principle plays a role in Chinese feet. In stress languages, whether a syllable is light or heavy is mostly defined by the rhyme structure (e.g., if the rhyme branches, the syllable is heavy; if it is non-branching, the syllable is light). However, in Chinese, the WSP is mainly defined by tonal structure (e.g., if the syllable is full-toned, it is "heavy"; if neutral-toned, then "light"). Because of these differences, it remains an empirical question whether the WSP in Chinese can be transferred into L2 English acquisition, and if so, in what way.

The second possibility is that the emergence of WSP-like patterns attested in Chinese-English interlanguage is activated by an intrinsic principle in the UG. This is the position held by several L2 researchers, such as Archibald and Pater. The principle is claimed to be innate and just needs to be triggered by the appropriate cue in the input data (Dresher & Kaye, 1990).

There is, however, a third possibility – that the attested WSP-like patterns have nothing to do with abstract principles no matter where they come from (whether

L1 or UG), but they are simply generalizations made by L2 learners based on the patterns in the input data. This question will be investigated in the next chapter.

#### **4.4. Chapter Summary**

In this chapter, we selected a group of Chinese learners whose identification of English tense/lax vowels reached native speaker levels in monosyllabic words, and tested their stress preferences in terms of a proposed universal mapping between stress and syllable structure (i.e., the universal tendency for syllables to be stressed if they contain a long vowel or a coda consonant). The experiments led to some interesting findings regarding the acquisition of L2 word stress by speakers of this tone language. One finding was that these learners' preferences generally followed the prediction of the universal mapping between stress and syllable structure. However, in addition to this general pattern, these L2 learners had a strong tendency to prefer a closed syllable to be stressed. This tendency was interpreted as their acquired L2 English knowledge being affected by their L1, i.e., the lack of a tense/lax (long/short) vowel contrast in Mandarin Chinese. The L1 transfer proposal is confirmed by the L2 learners' weak sensitivity to the mapping between stress and CVV syllables, as investigated in a further vowel identification task with disyllabic real words. It was found that their identification of vowels in multisyllabic words was not native-like and that their accuracy correlated with their preference for assigning stress to CVV syllables: the more accurate they were in identifying lax and tense vowels in multisyllabic words, the more sensitive they were to the mapping between stress and syllables containing a long vowel.

Finally, we raised the issue of how these L2 learners could have acquired the universal mapping between stress and syllable structure. Three possibilities were proposed: L1, universals and L2. Although Chinese is argued to have the WSP, it remains a question how this principle can be transferred from a tonal system to a stress system. The second and third possibilities (UG and L2) are discussed in the next chapter.



## **CHAPTER 5**

# **LEARNING MECHANISMS AND GENERAL DISCUSSION**

### **5.1. Introduction**

Building on the findings of Chapters 3 and 4, this chapter presents a general discussion of the learning mechanism which guides word stress development in Chinese-English interlanguage and the broader implications of our findings for research on L2 stress acquisition. Section 5.2 briefly reviews the main patterns attested in all the experiments conducted in the present study. Section 5.3 discusses the mechanisms which Chinese learners of English rely on in constructing their knowledge of English word stress; this issue is approached by examining whether the L2 subjects' stress preference patterns can be better accounted for on the basis of the metrical parameters of UG or on the basis of the distribution of English-specific stress patterns. Section 5.4 provides a reassessment of learning mechanisms of L2 stress acquisition, Section 5.5 presents the linguistic and typological implications of this study, and finally, Section 5.5 concludes the whole chapter.

### **5.2. Summary of Findings**

This section summarizes the crucial patterns of the acquisition of L2 English stress by Chinese-speaking learners which were found in the previous two chapters, with the purpose of examining the order in which different aspects of knowledge about English stress develop in Chinese learners of English.

In order to learn the English stress assignment of disyllabic and trisyllabic monomorphemic words, these learners need to master at least four things: (1) the noun-verb stress contrast (e.g., *im.port* (N) vs. *im.pórt* (V)); (2) the stress contrast conditioned by the presence/absence of a coda consonant, i.e., assigning penultimate stress when the penult is CVC (e.g., *a.gén.da*) but antepenultimate stress when the penult is CV (e.g., *Cá.na.da*); (3) the vowel segmental contrast, which requires that the learner is able to identify English lax and tense vowels (e.g., /ɪ, ɛ/ vs. /i, e/); and (4) the stress contrast conditioned by vowel type, i.e., assigning antepenultimate stress when the penult contains only a lax vowel CV (e.g., *Cá.na.da*) but penultimate stress when the penult contains a long vowel CVV (e.g., *a.ró.ma*). Two of these components are logically interconnected in these four areas of knowledge. Specifically, knowledge of the stress contrast which is conditioned by vowel type evidently presupposes knowledge of the vowel contrast: the acquisition of the stress contrast conditioned by vowel type (i.e., short/light vs. long/heavy) cannot logically occur before that of the vowel contrast (i.e., lax/tense). If learners are not able to distinguish between these two types of vowels at the segmental level, they will also have difficulty in determining the stress contrast caused by different types of vowels at a prosodic level. Therefore, L2 learners' knowledge about the vowel contrast is a prerequisite for testing their sensitivity to vowel weight, as was shown in Chapter 4. This study revealed the following features of the development of these essential components of knowledge.

Firstly, in Chapter 3, we investigated L2 learners' sensitivity to the noun-verb stress contrast and the stress contrast conditioned by the presence/absence of coda consonant (CVC vs. CV). Logically speaking, there were four possible ways learners

could pattern with respect to their knowledge of these two factors: (1) being sensitive to neither of them, (2) being sensitive to the noun-verb stress contrast but not the CVC/CV stress contrast, (3) being sensitive to the CVC/CV stress contrast but not the noun-verb stress contrast, and (4) being sensitive to both. The experimental results showed, however, that the actual patterns attested were more restricted than the patterns logically predicted. Of the 20 Chinese-speaking subjects, none of them showed sensitivity only to the CVC/CV stress contrast. This showed that by the time Chinese-speaking subjects were sensitive to the CVC/CV stress contrast, they must also be sensitive to the noun-verb stress contrast. In other words, their sensitivity to noun-verb stress contrast has been acquired no later than their sensitivity to the CVC/CV stress contrast.

Secondly, learners' knowledge of the stress contrast conditioned by syllable structure was tested in more detail in Chapter 4. We tested Chinese speakers' sensitivity to the mapping between stress and syllables which contain a long vowel or a coda consonant. Since the pairs of vowels used in the task (i.e., high front vowels /ɪ/-i/ and mid front vowels /ɛ/-e/) do not contrast in Chinese, the L2 learners could not have been expected to show sensitivity to the stress contrast conditioned by the two types of vowels in English unless they had previously acquired the vowel segmental contrast. Therefore, only those subjects whose identification of English lax and tense vowels was as successful as English natives' participated in the second set of stress preference experiments. Here again, there were four logically predicted patterns regarding L2 learners' sensitivity to the two variables (i.e., vowel type and coda consonant), but in this case, the learners showed all four patterns. As the by-subject analysis showed, 25% of the subjects (N = 5 out of 20) were found not to be

sensitive to the stress shift caused by either vowel type or the presence/absence of a coda consonant; 40% of the subjects ( $N = 8$ ) were sensitive to the stress contrast conditioned by the presence/absence of a coda consonant but not to the contrast conditioned by lax/tense vowels; 15% of the subjects ( $N = 3$ ) were sensitive to the stress contrast conditioned by lax/tense vowels but not that conditioned by the presence/absence of a coda consonant; and fourthly, 20% of the subjects ( $N = 4$ ) were sensitive to both factors. Although the latter three patterns differ from each other, they all follow the universal pattern that syllables containing a long vowel or a coda consonant tend to be stressed. The order of the acquisition of sensitivity to the mapping between stress and syllables containing a coda consonant on the one hand, and to the mapping between stress and syllables containing a long vowel on the other hand, cannot be established from these results alone since both the possibilities were attested.

The two main findings therefore consist of, firstly, the finding of Chapter 3 that the order of these L2 learners' sensitivity to the noun-verb stress contrast develops no later than their sensitivity to the stress contrast conditioned by the presence/absence of a coda consonant; and secondly, the finding from Chapter 4 that their sensitivity to the effects of coda consonants and vowel length on stress assignment is consistent with the proposed universal mapping between stress and syllable structure. In the following section, we focus our discussion on what kind of learning mechanism could guide the acquisition of L2 English stress based on these findings.



### 5.3. Learning Mechanisms

The learning mechanism which guides the acquisition of L2 English word stress by native speakers of Chinese is a central concern of this study. In Chapter 1, the two general views of language acquisition were reviewed.

The first view, parameter-setting, stemming from generative linguistics, argued that there is a set of a priori principles and parameters provided by UG, and that language acquisition is a process in which these innate principles and parameters are triggered. Evidence in support of this view comes from parallels between cross-linguistic and learner language data, e.g., the development from unmarked to marked structures. Although L2 learners' preference for the unmarked (or for phonological universals) has been widely reported in L2 syllables and segments, evidence for parameter-setting in L2 stress acquisition has not been widely reported so far. The suggestion has been made that there are patterns exhibited which are not apparently a copy of either the L1 or the L2 but nevertheless follow the parameterized principles of metrical phonology (Pater, 1997). In their reanalysis of Pater's study, van der Pas and Zonneveld (2004) suggest that UG does not only provide a set of metrical parameters but also a specific learning path which stipulates the order in which these parameters should be set by taking appropriate cues from the input data. So if the data show that learners can systematically take appropriate cues to set relevant parameters and follow a specific learning path, this may also suggest that they engage in parameter-setting. We would further stress that parameter-setting is categorical: the infrequent "exceptional" cases are said to be filtered out and do not trigger the setting of parameters, e.g., while "regular" *agenda*-type words will trigger



the setting of Quantity-Sensitive-to [Rhyme], “exceptional” words such as *chemistry* will not trigger the setting of this parameter.

The second view, statistical learning, puts its emphasis on the distributional facts of patterns observed in the ambient language and how acquisition is influenced by these probabilistic patterns. There is considerable evidence which shows that language development reflects the language-specific distributional properties of different sound patterns. Examples include learners’ preference for common and frequent sound patterns of the ambient language over rare and infrequent ones, and their being more accurate in producing and perceiving frequent sound patterns compared to infrequent ones. As Zamuner (2003) and Zamuner, Gerken, and Hammond (2005) have emphasized, when the structures that are unmarked across languages are also typically the most frequent within a specific language, it is difficult to tell whether the successful acquisition of these structures is due to the unfolding of innate knowledge provided by UG or to the effect of frequent patterns of the language-specific input. For instance, Zamuner and her colleagues have shown that although coronal codas are preferred cross-linguistically, if a child learns a language in which coronal codas happen to be the most frequently occurring codas, one cannot tell whether the child’s acquisition of coronal codas earlier than other types of coda is due to the effect of the unmarked structure of UG or to the effect of the frequent patterns of the ambient language.

These two theories can be distinguished only in the areas in which their predictions differ. For instance, when cross-linguistically unmarked structures and specific-language frequent patterns do not match completely, the acquisition data would provide a testing ground for the two learning views. Specifically, if learners

acquire unmarked structures before frequent structures, this would provide evidence in support of the UG hypothesis. On the other hand, if it was observed that frequent structures were acquired before unmarked structures, that would in turn support the stochastic learning hypothesis.<sup>1</sup> As a matter of fact, Zamuner (2003) and Zamuner, Gerken, and Hammond (2005) show that children's production of English coda consonants does not follow the prediction of UG (i.e., they do not produce all of the coronal codas before codas articulated in other places); instead, some non-coronal but frequent codas (e.g. /k/) were produced correctly earlier than other coronal codas. Evidence like this suggests that children's production is not simply guided by the principles of UG as a number of researchers have previously thought. Rather, the probabilities of phonological patterns of the ambient language seem to play an important role in phonological acquisition.

In the field of L2 stress acquisition, the dominant view expressed in the existing literature is that L2 English word stress is acquired via the setting of the metrical parameters of UG when L2 learners' L1 is also a stress language (e.g., Archibald, 1993b; Pater, 1997) even though the appropriateness of some their evidence is criticized by van der Pas and Zonneveld (2004) and in Section 2.3 of this study. On the other hand, some studies have shown that English stress patterns can be acquired from the distribution of the stress patterns in the input (e.g., Davis & Kelly, 1997). In the following section, we will re-examine the two views using the L2 English data of our Chinese learners of English, in the light of the implicational relationship between the acquisition of the noun-verb stress contrast and that of the stress contrast conditioned by the presence/absence of a coda consonant (based on

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<sup>1</sup> Zamuner (2003) and Zamuner, Gerken, and Hammond (2005) term it the "Specific-language Grammar Hypothesis".

the results of Chapter 3), and the various patterns which follow the universal tendency for syllables with a long vowel or a coda consonant to be stressed (based on the results in Chapter 4).

### **5.3.1 The Acquisition of the Noun-Verb Stress Contrast**

This section discusses the developmental pattern in which subjects' sensitivity to the noun-verb stress contrast precedes their sensitivity to the stress contrast which is conditioned by the structure of the penultimate syllable in trisyllabic nouns. We will show that the parameter-setting account is unable to provide a plausible explanation for this pattern, while the statistical learning account does.

#### **5.3.1.1. UG-based Parameter-Setting Account**

Under this framework, regular stress patterns are assumed to be derived from a set of universal metrical parameters in the core grammar, and any exceptional cases are stored individually in the lexicon. As far as bi- or trisyllabic monomorphemic words are concerned, there are three parameters which play a major role in determining their stress patterns: Extrametricality [Yes/No], Quantity-Sensitivity [QS/QI] and Quantity-Sensitive-to [Rhyme/Nucleus].<sup>2</sup> In English, the setting of the Extrametricality parameter is [Yes], and this is related to two further English-specific rules, Noun Extrametricality, which applies to nouns, and Consonant Extrametricality, which applies to verbs and adjectives. In addition, the WSP plays a role at the right edge of monomorphemic words. Here, the relevant parameters and their settings are Quantity-Sensitivity [QS] and Quantity-Sensitive-to [Rhyme].

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<sup>2</sup> Other relevant parameters would include Directionality of Foot Construction [Left-to-Right/Right-to-Left] and Word Headedness [Left/Right]. However, for the discussion of the patterns attested in this study, these three parameters are sufficient.

The application of these three parameters can be seen for instance in the two words, *insect* and *detect*. Both these words have exactly the same CVCC structure in the final syllable. Since the setting of the Extrametricality parameter in English is [Yes], it further activates the application of the two English-specific extrametricality rules; Noun Extrametricality applies to the noun and the resulting structure is *in.<sect>*, while Consonant Extrametricality applies to the verb and the resultant structure is *de.tec<t>*. Next, because of the settings of the two parameters Quantity-Sensitivity [QS] and Quantity-Sensitive-to [Rhyme], any syllable that has either a long vowel or a coda consonant at the right edge will be assigned primary stress. In the case of the verb *de.tec<t>*, the final syllable contains a coda consonant (i.e., CVC) after Consonant Extrametricality applies, so this syllable is assigned primary stress (*detéct*). On the other hand, the noun *insect* has stress on the penultimate syllable since the whole final syllable is invisible after Noun Extrametricality applies (*insect*).

A similar application of these three parameters determines the stress placement in trisyllabic nouns. Take the word set, *Canada*, *agenda*, and *aroma*, as an example. Since all three words are nouns, the setting of Extrametricality [Yes] activates the application of the Noun Extrametricality rule and yields the forms *Cana<da>*, *aro<ma>* and *agen<da>*. Next, the other two parameter settings (i.e., QS and QS-To [Rhyme]) assign stress to any heavy syllable at the right edge (e.g., a(ró)<ma> and a(gén)<da>), and if there is no heavy syllable, then a disyllabic trochee is constructed (e.g., (Cána)<da>). This parameter application results in the surface stress contrast of the three trisyllabic nouns.

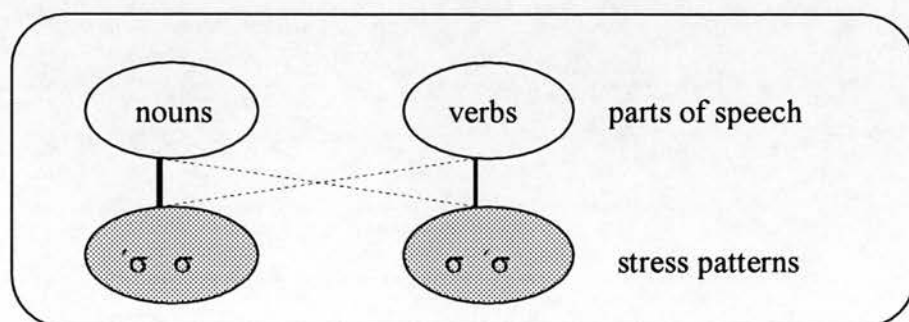
If L2 English word stress acquisition is regarded as a process of setting metrical parameters, the subjects who were able to show the noun-verb stress contrast in the disyllabic non-words which contained a CVCC final syllable (e.g., *dré.sect* (N) vs. *va.réct* (V)) would have set the three parameters above to the target-like values, i.e., Extrametricality [Yes], Quantity-Sensitivity [QS] and Quantity-Sensitivity-to [Rhyme]. In other words, successfully distinguishing the noun-verb stress contrast implies the application of the quantity sensitivity parameters to the difference between CVC<C> and CV<C>. But this also implies that the same learner should be able to detect the weight difference between  $\sigma.CVC.\sigma$  and  $\sigma.CV.\sigma$ . If this is the case, these learners would be expected to show sensitivity to the stress contrast in trisyllabic nonsense nouns as well (e.g., *na.tím.pa* vs. *bá.si.ka*). What was found in Chapter 3 was that 95% of the subjects (N = 19 out of 20) were sensitive to the noun-verb stress contrast, and only 40% of them (N = 8) were sensitive to the heavy penult (CVC) of trisyllabic nouns (e.g., preferring *drésect* (N) to *varéct* (V) and *natímpa* to *básika*). However, while 55% of them (N = 11) were sensitive to the noun-verb stress contrast (e.g., *drésect* (N) vs. *varéct* (V)), the same subjects were not sensitive to the heavy penult of trisyllabic nouns (e.g., *\*natímpa* (N) vs. *básika* (N)). Assuming that they could detect the /i/-/ɪ/ difference, adherence to the quantity-sensitive stress assignment is therefore not consistent in the two different tasks, and this inconsistency poses a problem for a parameter-setting account, which would not have predicted that the acquisition of the noun-verb stress contrast would occur before the stress contrast conditioned by the presence/absence of coda consonant.



### 5.3.1.2. Input-based Statistical Learning Account

Let us turn now to the input-based learning model to try to determine whether or not it can provide a plausible account for this pattern. Davis and Kelly (1997) explicitly argue that the knowledge of the English noun-verb stress contrast can be learned by non-native speakers without the mediation of phonological principles and rules. Instead, they argue, this distinction can simply be learned from the distributional facts of the lexicon, because of the strong correlation which exists between the surface stress patterns (strong-weak vs. weak-strong) and morpho-syntactic categories (nouns vs. verbs respectively). More than ninety percent of English disyllabic nouns have initial stress while about seventy percent of disyllabic verbs have final stress, according to Kelly and Bock's (1988) and Francis and Kucera's (1982) frequency analysis of English stress patterns. Given the strong correlation between surface stress patterns and morpho-syntactic categories, learners should be able to acquire the knowledge of stress placement in disyllabic nouns and verbs via statistical learning. The correlation is shown in Figure 5.1, in which the linking lines refer to the strength between surface stress patterns and syntactic categories: thick lines show a strong correlation and thin lines a weak correlation.

**Figure 5.1.** *Distribution of stress patterns in disyllabic nouns and verbs*

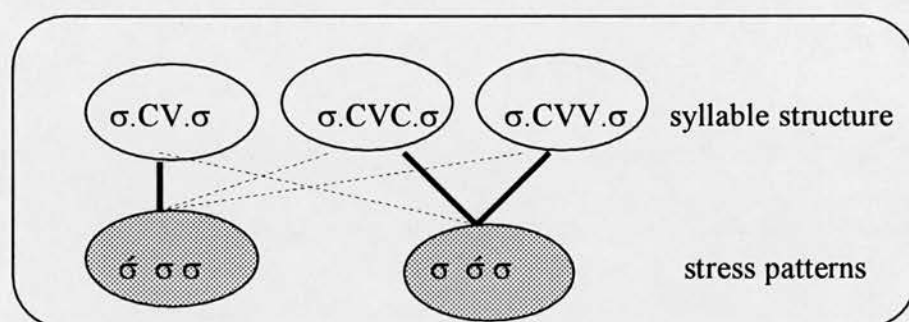


This view is also consistent with the findings of the present study. We postulate that our L2 subjects have two things to learn about English word stress assignment. The first is to identify the difference between the stress patterns of trochee and iamb (e.g., *pérmit* vs. *perμίt*). Davis and Kelly have suggested that such a distinction is easy for non-native speakers to detect regardless of their L1 background. Learners can then use this ability to generalize these stress patterns by referring to their statistical correlates to the morpho-syntactic categories. This account serves as an alternative to the parameter-setting account. The noun-verb stress contrast does not necessarily involve the application of extrametrical rules: instead, learners may note that most disyllabic nouns have stress on the initial syllable while most disyllabic verbs have stress on the final syllable. This proposal explains why the noun-verb stress pattern can be easily acquired by L2 learners regardless of their L1 (whether stress or tone).

It should be emphasized, however, that unlike the parameter-setting model, which assumes that stress patterns in a language are acquired by analyzing them consistently into either trochaic or iambic feet, the surface stress patterns in the statistical learning model are unanalyzed chunks or words. For instance, in the stress patterns of disyllabic words above, both trochaic and iambic patterns are allowed in a language. Although the concept of “unanalyzed stress chunks” is not explicitly claimed in the psycholinguistic studies which suggest stress patterns can be learned statistically, it is implied. For instance, Davis and Kelly use both of the terms trochee and iamb in describing English stress, but such patterns are not analyzed by the application of any metrical rules or principles in the core grammar. They also suggest that the occurrence of these two patterns, which are isomorphic to a disyllabic word,

can be learned simply from the distribution, if the two patterns can be correlated with two lexical classes. If we extend this view to the stress patterns of trisyllabic nouns, the cue of lexical classes is no longer workable since all of the words are in the same morpho-syntactic category. The cues available in this case are purely phonological (i.e., syllable structure), as presented in Figure 5.2. The distributional facts of these patterns are presented in Section 5.3.2.2 below.

**Figure 5.2.** *Distribution of stress patterns in trisyllabic nouns*



If learners are able to use the cue of syllable structure and notice its correlation with stress patterns,  $\acute{\sigma} \sigma \sigma$  and  $\sigma \acute{\sigma} \sigma$ , then the stress patterns of English trisyllabic nouns can be learned too. Again, whether the surface stress patterns are constructed into metrical feet is not of concern in this model. However, we assume them to be unanalyzed in this study in order to distinguish them from the parameter-setting model and to be consistent with Davis and Kelly's view that English stress patterns can be learned from the distribution without the phonological application provided by UG.

In comparison with the morpho-syntactic cues in disyllabic words, the cue of syllable structure is more subtle and would probably take more time for L2 learners

to acquire. This difference probably explains why so many learners have failed to acquire the distinction even though they have been learning English for a considerable period of time. Under the input-based statistical learning hypothesis, it is suggested that due to the salience of the morpho-syntactic information, L2 learners are able to use morpho-syntactic cues to generalize the different stress patterns by a certain developmental stage. However, identifying the presence or absence of a coda consonant as a cue which correlates with stress patterns is a different thing, and probably takes a longer period of time to learn from the input. For instance, Guion, Harada and Clark (2004) indicate that their late learners' assignment of stress to non-words is sensitive to lexical classes and phonological similarities, but not to syllable structure. This means that syllable structure as a cue in learning English stress patterns might occur later or never in L2 adult learners. In other words, unlike the parameter-setting account, the statistical learning hypothesis allows the learning of the noun-verb stress contrast in disyllabic words to take place independently of the stress contrast conditioned by the presence/absence of coda consonant in trisyllabic nouns.

Although we have argued that the L2 learners' sensitivity to the noun-verb stress contrast and their lack of sensitivity to the heavy penult of trisyllabic nouns cannot be explained satisfactorily from the parameter-setting model, one might argue that this part of knowledge of the noun-verb stress contrast in English is learned separately from the core grammar. In other words, the timing inconsistency is arguably not enough to exclude the parameter-setting model as a plausible L2 stress learning mechanism. This is mainly because, if the noun-verb stress contrast is interpreted as being learned outside the core grammar defined by metrical parameters,



then there is no other evidence to suggest that L2 learners' stress patterns go against the cross-linguistic tendency of stress assignment (assigning stress to light syllables rather than heavy syllables). In summary, although there is some room for interpretation with the parameter-setting model as well, the input-based model provides a better explanation for the L2 English stress patterns which emerged in Chapter 3.

### **5.3.2. The Acquisition of the Universal Mapping between Stress and Syllable Structure**

The main finding of Chapter 4 was that L2 learners assign stress to trisyllabic nouns following the prediction of a proposed universal mapping between stress and syllable structure, i.e., syllables which contain a long vowel or a coda consonant tend to be stressed. In Section 4.4.3 it was suggested that the general patterns attested can be analysed in metrical terms, i.e., as being consistent with the abstract WSP of UG. On the other hand, these patterns can also be analyzed in the non-metrical way, i.e., as a generalization of English stress patterns based on the input data without the implementation of any abstract principles. In the following discussion of these two possibilities, it will be shown that at a very general level, both parameter setting and statistical learning can account for the data equally well. However, when we look into the data more closely, it seems that the statistical learning account fares better than the parameter-setting hypothesis.



### 5.3.2.1. UG-based Parameter-Setting Account

Overall, our L2 learners' preference for penultimate stress in trisyllabic nonsense nouns is consistent with the prediction of the WSP. That is, when the penultimate syllable was light (i.e., CV), then the subjects preferred antepenultimate stress. In addition, these subjects preferred penultimate stress to different degrees for the other three types of syllable structure, i.e., they were sensitive to words containing either a coda or a long vowel. Three sub-patterns of their varying sensitivity were found (as summarized in Section 5.2 of this chapter). One interpretation might therefore be that the universal WSP (or two metrical parameters, i.e., QS [Yes/No] and QS-to [Rhyme/Nucleus]) is guiding their acquisition of the assignment of stress to the heavy penult. When these parameters are set, anomalies (e.g., insensitivity to long vowels) may sometimes emerge due to other factors such as L1 transfer and the fragility of L2 vowels. In summary, what this model can predict is that heavy syllables should receive stress rather than light syllables. Specifically, CVV as a class should tend to be stressed rather than CV as a class, and similarly CVC as a class should tend to be stressed rather than CV. The overall picture generalized from the results would seem to support such a view if the data were analyzed at this very general level. Therefore, one possible account of L2 learners' sensitivity to heavy syllables (CVV, CVC or both) is that they engaged in parameter-setting. However, before such a conclusion can be drawn, let us examine the other view of learning.

### 5.3.2.2. Input-Based Statistical Learning Account

Even though the previous section has shown that the stress patterns acquired by our Chinese learners of English looked like they were sensitive to syllable weight

and can be explained from the perspective of the UG-based parameter-setting model at a very general level, this section examines whether these patterns can also be explained from the distribution of the English input data, i.e., whether words with a CVVC, CVV or CVC penult are more likely to be stressed on the penultimate syllable than words with a CV penult.

We undertook an analysis based on a search of the English CELEX lexical database. Although our objective was to analyse the monomorphemic trisyllabic nouns of English, it turned out that there were only 700 of these words in the database. Therefore we included bimorphemic trisyllabic nouns in the analysis too.<sup>3</sup> And indeed, if stress patterns are learned via the domain-general statistical learning mechanism, the generalization does not necessarily have to be based on monomorphemic words only; rather, it is more likely that the stress patterns of all trisyllabic words will be the source of generalization, whether monomorphemic or not. The search criteria were set to retrieve words based on four types of penultimate syllable structures (i.e., CV, CVC, CVV and CVVC) and two stress patterns (i.e., antepenultimate stress and penultimate stress). There were 2288 instances retrieved in total. The details of type and token frequency are listed in Table 5.1. Type frequency refers to the count of word types (i.e., lexical items) in which the penult contains a certain type of syllables (i.e., CV, CVC, CVV or CVVC) while token frequency refers to the count of word occurrences containing a certain type of syllable in each million running words recorded in the corpus. The number in each cell of the table indicates the proportion of the two stress patterns in each syllable type, so, for example, in the first row (CV), the proportion of word types with a CV

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<sup>3</sup> Hammond (1990) calculated that there are 2074 trisyllabic monomorphemic nouns in English (p. 194). However, many of these words are infrequent and not even included in the CELEX database.

penult and antepenultimate stress is calculated as the frequency of words with antepenultimate stress (i.e., 1220) divided by the frequency of all words with a CV penult (i.e., 1220 plus 184), i.e., 87%. The remaining 13% of instances have penultimate stress. The other cells were calculated in the same fashion.

**Table 5.1.** *Distribution of stress patterns of English trisyllabic nouns*  
(Sample = 2288)

	Antepenultimate stress (ó σ σ)		Penultimate stress (σ ó σ)	
	Type frequency	Token Frequency	Type Frequency	Token Frequency
σ.CV.σ	87% (N = 1220)	87%(N = 14429)	13% (N = 184)	13% (N = 2099)
σ.CVV.σ	16% (N = 78)	10%(N = 348)	84% (N = 410)	90% (N = 3483)
σ.CVC.σ	36% (N = 115)	36% (N = 1129)	64% (N = 201)	64% (N = 2009)
σ.CVVC.σ	10% (N = 8)	9% (N = 104)	90% (N = 72)	91% (N = 1071)

Table 5.1 shows that, generally speaking, there is a systematic mapping between stress placement and the structure of the penult in trisyllabic nouns. In words with a CV penult (e.g., *á n i m a l*), stress falls on the antepenultimate syllable in 87% of cases. Words with a CVV, CVC or CVVC penult receive penultimate stress more often than antepenultimate stress (i.e., 84% when the penult is CVV (e.g., *a r ó m a*), 64% when the penult is CVC (e.g., *a g é n d a*), and 90% when the penult is CVVC (e.g., *a c h i e v e m e n t*). Token frequencies also show similar patterns. In other words, there is a two-way division in the general distribution of the mapping between stress pattern and the structure of the penultimate syllable: (1) when the penult is CV, then assign antepenultimate stress, and (2) when the penult is CVV, CVC or CVVC, then assign penultimate stress. This pattern is consistent with the prediction of the WSP (or the QS and QS-to Rhyme parameter-settings). Therefore, these learners' preference for stress on CVV, CVC and CVVC penults of trisyllabic nouns can be accounted for by

either model, i.e., the effect of the universal WSP or the effect of the distribution of English stress patterns. At this very general level, therefore, it is difficult to judge which hypothesis is more adequate in interpreting the acquisition of L2 English stress patterns (the same dilemma as has been pointed out by Zamuner (2003) and Zamuner, Gerken, and Hammond (2005)).

Although the mapping between the structure of the penultimate syllable and stress patterns in English can be roughly divided into these two groups, it is noticeable that the actual distributions of these stress patterns are gradient. For example, trisyllabic nouns with a CVVC penult ( $\sigma.CVVC.\sigma$ ) have penultimate stress 90% of the time while those with a CVC penult ( $\sigma.CVC.\sigma$ ) have penultimate stress only 64% of the time, and so on. Recall the result of stress preference of trisyllabic non-words in the group of English native speakers in Chapter 4. Although the overall result showed that these English subjects prefer penultimate stress for  $\sigma.CVVC.\sigma$ ,  $\sigma.CVV.\sigma$  and  $\sigma.CVC.\sigma$  words, and antepenultimate stress for  $\sigma.CV.\sigma$  words, the degree of their preference for penultimate stress is different among the three types of words (i.e., 72% for  $\sigma.CVVC.\sigma$ , 78% for  $\sigma.CVV.\sigma$  and 68%  $\sigma.CVC.\sigma$ ). In other words, the English subjects' stress preferences are gradient, and so are the Chinese subjects' (i.e., 72% for  $\sigma.CVVC.\sigma$ , 69% for  $\sigma.CVV.\sigma$  and 50%  $\sigma.CVC.\sigma$ ). However, although these subjects' results suggest that their knowledge about English stress patterns is gradient rather than categorical – an indication that they may have learned these patterns by tracking the statistical distribution of stress patterns in the input data – this result is not used as the main argument for statistical learning here because the matching is not particularly close and the possibility of experimental artefacts cannot be excluded, as was discussed in Section 2.2.1.3. More evidence



which is more capable of distinguishing the two learning views will be explored below.

In addition to the “gradient vs. categorical” distinction, the two learning mechanisms do make different predictions when we look into the input data of stress patterns in more detail. Specifically, since there are five lax vowels in English, the CV penult includes five sub-types (Cɪ, Cɛ, Cʌ/Cə, Cæ, and Cʊ),<sup>4</sup> and the CVV penult contains six sub-types (Ci, Ce, Cu, Co, Cɔ, Cɑ). Table 5.2 (overleaf) presents the distributional characteristics of vowel-to-stress mapping in the penultimate syllable of English trisyllabic nouns based on the CELEX database. The reason for presenting only these four vowels is that they were the ones used in our experiment, and our purpose here was to compare their distribution with the subjects’ treatment of them in the non-words.

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<sup>4</sup> Since the vowels /ə/ and /ʌ/ are not contrastive (i.e., /ə/ occurs in unstressed position and /ʌ/ in stressed position) (Hammond, 1999), we do not distinguish them in our analysis. In addition, there is some debate over whether the vowels /ɔ/ and /ɑ/ should be classified as lax or tense vowels. For example, Hammond (1999) classifies them as tense whereas Goldsmith (1990) treats them as lax. Neither of these issues has a bearing here since our experiment uses the vowel pairs /ɪ/-/i/ and /ɛ/-/e/, which contrast in all English dialects.



**Table 5.2.** *Distribution of stress patterns of trisyllabic nouns (detailed by vowels)*

	Antepenultimate stress		Penultimate stress	
	Type Frequency	Token Frequency	Type Frequency	Token Frequency
$\sigma$ .CV. $\sigma$ (all)	87% (N = 1220)	87% (N = 14429)	13% (N = 184)	13% (N = 2099)
$\sigma$ . C/i/. $\sigma$	88% (N = 532)	88% (N = 7744)	10% (N = 59)	12% (N = 1045)
$\sigma$ . C/e/. $\sigma$	15% (N = 4)	3% (N = 18)	85% (N = 22)	97% (N = 549)
$\sigma$ .CVV. $\sigma$ (all)	16% (N = 78)	8% (N = 348)	84% (N = 410)	92% (N = 3862)
$\sigma$ . C/i/. $\sigma$	4% (N = 2)	8% (N = 32)	96% (N = 46)	92% (N = 352)
$\sigma$ . C/e/. $\sigma$	4% (N = 4)	6% (N = 52)	96% (N = 98)	94% (N = 882)
$\sigma$ .CVC. $\sigma$ (all)	36% (N=115)	36% (N = 1129)	64% (N = 201)	64% (N = 2009)
$\sigma$ . C/i/C. $\sigma$	56% (N=40)	56% (N = 282)	44% (N = 32)	44% (N = 219)
$\sigma$ . C/e/C. $\sigma$	6% (N=6)	2% (N = 32)	94% (N = 97)	98% (N = 2005)
$\sigma$ .CVVC. $\sigma$ (all)	10% (N=8)	9% (N = 104)	90% (N = 72)	91% (N = 1071)
$\sigma$ . C/i/C. $\sigma$	0% (N=0)	0% (N = 0)	100% (N = 8)	100% (N = 94)
$\sigma$ . C/e/C. $\sigma$	8% (N=1)	2% (N = 2)	92% (N = 12)	98% (N = 100)

It is clear from Table 5.2 that the distribution of these vowels in the penultimate syllable of trisyllabic nouns and their stress patterns in the English lexicon does not always match the prediction of the parameter-setting model. The parameter-setting model predicts that trisyllabic nouns with a CV penult as a class should receive antepenultimate stress (e.g., *Cánada*). However, the distribution of stress patterns in English, as evidenced by the CELEX database, does not in fact support this prediction. For trisyllabic nouns with a Ci penult, the proportion of antepenultimate stress is 88% and that of penultimate stress is 12%. This is consistent with the pattern that  $\sigma$ .CV. $\sigma$  words mostly receive antepenultimate stress, but, on the other hand, for trisyllabic nouns with a Ce penult, the pattern turns out to be contrary to the predictions of the WSP: 15% of these words have antepenultimate stress and 85% have penultimate stress. This pattern probably results from two factors. Firstly, English lax vowels in the unstressed position are usually reduced to either /ə/, /ɪ/ or /ʊ/, and the vowel /e/ rarely surfaces in unstressed syllables. In other words, when

learners perceive /ɛ/, it is usually stressed and they seldom hear it in unstressed position. Secondly, some trisyllabic words with a Cɛ penult in English have the “exceptional” stress pattern – instead of being assigned antepenultimate stress as the English stress theory predicts, the “exceptional” cases receive penultimate stress (e.g., *dilémma* and *eléven*). The combination of these factors produces the distribution of English stress patterns, i.e., words with a Cɛ penult receive penultimate stress more frequently than antepenultimate stress. An anomaly in the opposite direction is also found in the stress patterns of words with a CVC penult. While words with a CVC penult as a class have penultimate stress 64% of time, words with a CɪC penult tend to have antepenultimate stress rather than penultimate stress. This is probably due to the fact that the vowels /ɪ/ and /ʊ/ in English are two of the reduced vowels; in this case, their status is equivalent with schwa and they do not receive stress. This increases the frequency with which σ.CɪC.σ words are mapped with antepenultimate stress, and goes against the theoretical generalization that CVC is mapped with penultimate stress. In other words, when L2 learners hear a penult that contains the vowel /ɛ/, regardless of syllable structure, it tends to be stressed. Similarly, when L2 learners hear a penult that contains the vowel /ɪ/, regardless of syllable structure, it tends to be unstressed. However, if L2 learners follow patterns which come from the parameterized approach, the only thing that matters is whether it is CV or CVC and then the learners should follow a pattern that does not distinguish Cɛ from Cɪ, or CɪC from CɛC. The predictions of the two learning mechanisms are shown in (5.1) (overleaf).

(5.1)

- a. Parameter-setting prediction:** Both  $\sigma.C\epsilon C.\sigma$  and  $\sigma.CiC.\sigma$  words have penultimate stress, while  $\sigma.C\epsilon.\sigma$ ,  $\sigma.Ci.\sigma$  words have antepenultimate stress.
- b. Statistical learning prediction:** Both  $\sigma.C\epsilon C.\sigma$  and  $\sigma.C\epsilon.\sigma$  words have penultimate stress, while  $\sigma.CiC.\sigma$  and  $\sigma.Ci.\sigma$  words have antepenultimate stress.

The results of Chapter 4 were presented previously by collapsing the responses for the two vowels in each syllable type. We now present the results again with the vowels separated, focusing on  $\sigma.CVC.\sigma$  and  $\sigma.CV.\sigma$  words only. This is because there is no apparent difference between two stress patterns observed from the subtypes of  $\sigma.CVV.\sigma$  and  $\sigma.CVVC.\sigma$  words (i.e.,  $\sigma.Ci.\sigma$ ,  $\sigma.C\epsilon.\sigma$ ,  $\sigma.CiC.\sigma$  and  $\sigma.C\epsilon C.\sigma$ ) – the two learning mechanisms make the same predictions in the case of penultimate syllables with a long vowel. Now let us have a look at L2 learners' preference for penultimate stress in the case of  $\sigma.Ci.\sigma$  and  $\sigma.C\epsilon.\sigma$  words. The details are presented in Table 5.3. Our L2 subjects preferred  $\sigma.C\epsilon.\sigma$  words to have penultimate stress more often  $\sigma.Ci.\sigma$  words. A t-test confirms that the subjects' penultimate stress preferences between  $\sigma.C/i/.\sigma$  and  $\sigma.C/\epsilon/.\sigma$  words are significantly different ( $t(19) = 9.98$ ,  $p < 0.001$ ). This pattern cannot be explained by the WSP (or parameter-setting).

**Table 5.3.** *Chinese subjects' preference for antepenultimate stress when the penult is Ci or Cε (N = 20)*

	$\sigma\sigma\sigma$ Mean in %	s.d. in %
$\sigma.Ci.\sigma$	15.1	15.72
$\sigma.C\epsilon.\sigma$	84.9	15.72

Table 5.4 shows that the L2 learners' preference pattern for the  $\sigma$ .CVC. $\sigma$  words, grouped by vowel type. Their preference for penultimate stress for  $\sigma$ .C $\epsilon$ C. $\sigma$  words is significantly different from  $\sigma$ .CiC. $\sigma$  words ( $t(19) = 9.47, p < 0.001$ ). This pattern cannot be explained by the WSP either.

**Table 5.4.** *Chinese subjects' preference for penultimate stress when the penult is CiC or C $\epsilon$ C ( $N = 20$ )*

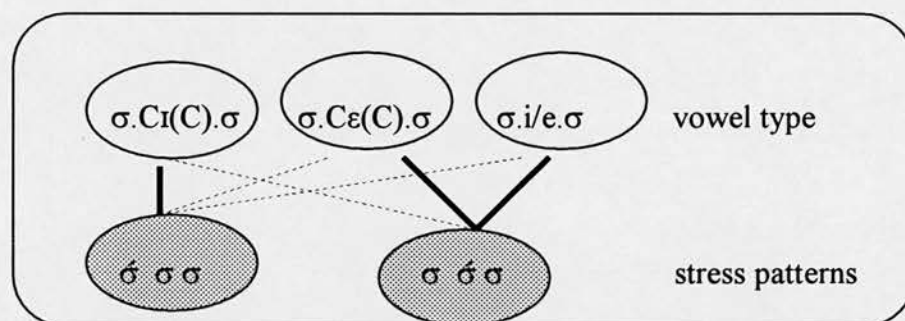
	$\sigma\acute{o}\sigma$ Mean in %	s.d. in %
$\sigma$ .CiC. $\sigma$	27.5	10.61
$\sigma$ .C $\epsilon$ C. $\sigma$	72.5	10.61

In summary, this evidence suggests that the Chinese-speaking learners of English acquire English stress patterns of trisyllabic nouns through statistical learning, using the cue of vowels or analogy with segmentally similar-sounding words. Specifically, when the penultimate syllable of trisyllabic nouns contains the vowel / $\epsilon$ /, penultimate stress is preferred regardless of syllable structure (CV or CVC). Similarly, when the penultimate syllable contains the vowel / $i$ /, antepenultimate stress is preferred regardless of syllable structure too. In other words, the statistical learning model presented in Figure 5.2 should be modified to be Figure 5.3 below, where the generalization of stress patterns is based on vowels rather than syllable structure. These results are opposed to the categorical prediction of the parameter-setting model, i.e., that CVC as a class should tend to be stressed whereas CV as a class should tend not to be stressed. In other words, if learners followed rules or principles which come from the innate UG, the only thing that would matter is the stress



mapping between CV and CVC, regardless of factors such as the language-specific change of the vowel quality in different contexts.

**Figure 5.3.** *Distribution of stress patterns in trisyllabic nouns (by vowels)*



Combining this finding with the analysis presented in Section 5.3.1 that the timing discrepancy of our L2 learners' sensitivity to the noun-verb stress contrast could not be explained by parameter-setting satisfactorily either, we suggest that the parameter-setting account has not been shown to be capable of modelling L2 English stress acquisition by Chinese speakers. On the other hand, the input-based statistical learning model seems to provide a better account for the L2 patterns attested. The relationship between the probabilistic stress patterns of the ambient language and the knowledge of L2 English stress which these learners have acquired appears to be more complicated than the standard parameter-setting model has expected.

## 5.4. Reassessment of the Learning Mechanisms for L2 Stress

### Acquisition

This section discusses the implications of the findings from Chapters 3 and 4 for the two learning mechanisms. Before we embark on this discussion, however, it



should be noted these learning models are neither completely complementary nor wholly mutually exclusive. Although there are various specific claims within each view, parameter-setting and statistical learning both come with whole packages of ideas, some of which overlap and some of which do not. In order to make the assessment of the two models relevant to the question of stress acquisition, therefore, we discuss two component questions: (i) the role of the input and, (ii) metrical constituents.

Regarding the role of the input, both the learning models start from the premise that learning is based on some sort of cue from the input data. In the parameter-setting model, cues serve to trigger the setting of parameters (for instance, the presence of stress movement according to syllable weight triggers the setting of the Quantity-Sensitivity parameter (see Section 2.1.2.1). In the statistical learning model, cues serve as the basis for learners to generalize various stress patterns from the distribution (see Section 2.1.2.2). Even though cues from the input data are crucial for learning to take place in both of the learning models, there are several apparent differences between the two views which need to be discussed further. Firstly, the parameter-setting model stipulates that parameters can be triggered only when the appropriate cues are present (e.g., the relation between syllable structure/syllable weight and stress placement). However, cues in the statistical learning model are less constrained, e.g., the stress patterns can be generalized based on various cues such as lexical classes, syllable structure or even individual vowels as long as such cues can help distinguish the various stress patterns. Because the standard parameter-setting model requires, for example, that the QS parameter is triggered by syllable structure (or syllable weight), it is not clear before L2-like syllable structure is acquired by L2

learners at any given stage whether these learners are acquiring stress patterns or not; or if so, in what way. On the other hand, since the cues used in the statistical learning model may vary both across learners and at different L2 stages, the acquisition of stress patterns and syllable structure (or syllable weight) may occur at the same time. For instance, before L2 learners acquire the abstract L2 syllable structure, they can use other cues available to them (such as lexical classes and vowels) to generalize stress patterns. The latter case is indeed what we have seen in these Chinese speakers learning English stress: (i) the noun-verb stress contrast they have acquired has a very close match with the statistical distribution of the stress patterns of English disyllabic words regardless of the structure of their final syllable, and (ii) the stress patterns of English trisyllabic nouns preferred by these learners suggest that the generalization was based on vowels rather than abstract syllable structure. Similar findings are also reported by Guion, Harada, and Clark (2004), who show that their late Spanish learners assign L2 English stress by using information about lexical classes and phonologically similar words but not syllable structure.

Secondly, since the parameter-setting model assumes a distinction between the core grammar and the lexicon, only regular instances can influence parameter-setting whereas irregular (or exceptional) instances must be stored separately in the lexicon. On the other hand, the statistical learning process does not separate regular from irregular instances; rather, both kinds of instances are part of distribution of the input data and influence the process of generalization. Following on from this, the grammar constructed by means of parameter-setting is categorical whereas that constructed via statistical learning is gradient. However, very few pieces of evidence are available in the area of stress acquisition (see Section 2.3.1.2), so although the

theoretical predictions between the two models are clearly different, the difference between them is hard to see empirically at least in the area of L2 stress acquisition so far.

In addition to the role of input data, the construction of abstract metrical constituents is another crucial issue in learning stress patterns, and one which is treated differently by the two models. In the parameter-setting model, stress is assumed to be assigned based on metrical constituents such as feet and phonological words. Therefore, the construction of these abstract units is essential in the acquisition of a stress system. Nevertheless, Dresher (1999) proposes that, from the point of view of learnability, parameters are not set all at once; rather, the grammar develops gradually from simple to complex and from concrete to abstract following a specified path. Therefore, the Quantity-sensitivity parameter is assumed to be the first that is set, because learners only need to pay attention to whether stress shifts according to syllable weight. On the other hand, other parameters such as Word headedness, Foot headedness and Directionality of foot construction may be set later since these parameters are in charge of the construction of abstract metrical units. In other words, whether or not learners are able to construct metrical constituents is not really crucial at the earlier stages since the earlier grammar should be simpler and more concrete, rather than particularly complex or abstract. However, as the grammar gradually develops, the construction of metrical constituents is predicted to happen as exposure increases, as long as the appropriate cues for parameter setting appear in the input data.

In the statistical learning model, on the other hand, this issue of the construction of abstract metrical constituents is not explicitly discussed, simply because it is not

the main concern of the relevant studies. In other words, statistical learning does not assume that the development of abstract metrical constituents must happen, but it does not assume that it must not happen either. For instance, Davis and Kelly (1997) and Gioun, Harada, and Clark (2004) suggest that the noun-verb stress contrast in English disyllabic words can be learned simply by mapping the two surface stress patterns with the two lexical classes. In other words, the surface stress patterns are not necessarily analyzed into metrical units such as feet or phonological words. Following Davis and Kelly's line, we propose an alternative non-metrical analysis of the stress patterns in trisyllabic nouns, which are also unanalyzed stress chunks: our data show that it is quite possible for the stress of English trisyllabic words to be learned via statistical learning for English trisyllabic words. Our learners do track the statistical distribution of stress patterns defined by vowels rather than simply set the parameters of UG. However, we must still acknowledge that even if statistical learning can account for the acquisition of primary stress assignment in English words with two to three syllables just as well as or even better than the parameter-setting model, it has not yet been demonstrated that it also accounts for the acquisition of stress assignment in longer words or in words where primary and secondary stress co-occur. This is because learning the stress system by simply mapping unanalyzed stress chunks with some sort of cue in these situations will become increasingly problematic as word length increases. We therefore conclude that an exhaustive comparison of how the statistical learning model fares with longer words remains a matter for further empirical investigation.

In short, the statistical learning model is able to provide a better account than the parameter-setting model of the acquisition of stress in shorter words, and a more



reasonable case for stress learning at the earlier stage when the L2 syllable structure has not been acquired. Of course, the two learning mechanisms discussed in this study are just two possible accounts of L2 stress acquisition at opposite extremes. There might be a third or several more possibilities – it may be that L2 learners use both statistical learning and parameter-setting in acquiring a new stress system. Or it could be that they make generalizations about various types of representations in order to produce longer words. Nevertheless, it should be emphasized again that what these L2 learners have done is not simply to set the parameters of UG.

An implication extended from the point above is that the construction of models of L2 stress acquisition using the generative approach needs to be modified. In Dresher & Kaye's parameter-setting model, the machine learner enters the stress learning task with some pre-set knowledge. First, the learner is equipped with fully developed segmental knowledge, including knowledge of short and long vowels. Secondly, the learner does not have to determine where the syllable boundary is in a sequence of sound segments because this job is done in the input: the syllable structure of the target language is known to the learner from the start of the stress assignment acquisition process. In addition, the learner is able to use overt forms exclusively and further determines the setting of any relevant parameters (e.g., CVC is stressed). However, these three knowledge components do not necessarily exist in the human adult acquiring L2 stress. In the real situation, the learner may acquire segments, prosodic structure and stress assignment simultaneously. In addition, when the syllable structure in a learner's L1 and L2 is not identical, the learner may have difficulty in parsing L2 sound sequences into syllables. Fourthly, because of the differences between the L1 and L2, the L2 learner might miss something and be



unable to use the appropriate cue to set parameters even though the information is provided overtly (e.g., Mandarin Chinese does not have obstruent codas, so its speakers may not be able to parse CVO sequence into the same syllable in some stage, which influences their setting of Quantity-Sensitive-to [Rhyme].) Given the evidence presented in this thesis, we would suggest that the parameter-setting model of human stress acquisition should devote at least some attention to how stress is acquired in the stages in which learners have not learned the relevant segmental contrasts or prosodic structures.

The ability of Dresher & Kaye's machine learner to set parameters based on overt forms in the input data is particularly problematic in the acquisition of English stress. A general example of using overt forms in learning would be the case of learning a quantity-sensitive language which is sensitive to rhyme, where the overt forms must show that syllables containing a coda consonant or a long vowel are stressed, and syllables containing neither of them are not stressed. Our results show that in the case of English stress acquisition, this is not likely to be a realistic assumption. This is because in English certain forms seldom appear overtly, so if one assumes that parameters can be set only based on the input data, there should be a noticeable impact on the learners' setting of parameters. As presented earlier, in English trisyllabic nouns, when the penultimate syllable is open and unstressed, the vowel is usually reduced (e.g., /ə/, /ɪ/ or /ʊ/). Because the vowel /ɛ/ never surfaces in the unstressed penultimate syllable, this is likely to interfere with the acquisition of the weight implication of the vowel /ɛ/ and its stress status, which further influences the acquisition of the different weight implications of Cɛ vs. CɛC. Furthermore, the parameter-setting model also has to guarantee that the learner will not be misled by

exceptional but frequent cases (e.g., *dilemma* /dɪ.lé.mə/, where the Cɛ is stressed). In summary, previous studies using this framework have not presented evidence of how L2 learners could learn stress patterns which do not appear overtly. Given the evidence presented in this study that L2 learners generalized stress patterns based on the overt forms in the input data, before we can use the parameter-setting model as a realistic model of L2 stress acquisition, an explanation needs to be provided as to how learners can set parameters when some cue in the overt forms is missing (e.g., Cɛ in the unstressed syllable is absent in the input data).

If the current parameter-setting model does not explain our data satisfactorily, one might wonder whether or not other generative phonological frameworks could do so instead. Some researchers use Optimality Theory (OT) to model stress acquisition (e.g., Tesar & Smolensky, 1998, 2000; Apoussidou & Boersma, 2003). These models share with the parameter-setting model the idea that metrical constraints are innately provided by UG, and that cross-linguistic variation arises from different constraint ranking. However, the strictly ranked versions of OT encounter the same problems as the parameter-setting model discussed above, i.e., they fail to account for stress acquisition in the stages where the relevant segmental contrast and syllable structure have not fully developed. In addition, they fail to account for how the learner is able to set parameters when some of the relevant cues are missing in the overt forms.

Although standard OT appeals to the idea that constraints are innately provided by UG, some studies argue that constraints can be learned (e.g., Boersma, 1998). Using English stress acquisition as an example, it might be the case that L2 learners make generalizations across the input data. For instance, if they focus on the

penultimate syllable of trisyllabic words, several generalizations can potentially be made, such as (i) when it contains the vowel /ɛ/, the word is stressed (e.g., *agenda* /ə.dʒɛn.də/ and *dilemma* /dɪ.lɛ.mə/), and (ii) when it contains the vowel /ɪ/, it will have antepenultimate stress (e.g., *article* /ɑr.tɪ.kl/ and *calender* /kæ.lɪn.dər/). But L2 learners will also meet counter-examples to these generalizations in the shape of some frequent words such as *vanilla* /və.nɪ.lə/, and another new generalization needs to be made: (iii) when the penult contains the vowel /ɪ/, the word will have penultimate stress. And these generalizations (or constraints) compete together based on the regularities observed in the input data. In advanced learners, more general constraints may be postulated: (iv) when the penult contains only a lax vowel, antepenultimate stress is assigned; (v) stress falls on the penult when it contains a coda consonant or a long vowel. The advantage of learning constraints avoids the problem of learners having to determine the weight contributed by certain segments in spite of the lack of overt evidence in the input data.

In addition to constraint learning, the OT stress acquisition model needs to accommodate the probabilistic nature of stress patterns in a language. This is an issue of how constraints are ranked. Although some researchers argue that the constraints are strictly ranked (Tesar & Smolensky, 1993, 1998; Prince & Smolensky, 1993), others suggest that the relationship between constraints is stochastic (Boersma, 1998). For example, Boersma's model (1997, 1998) allows for variability and optionality, and the relative frequency of variants can be encoded into the grammar. Given the finding of this thesis, we would suggest the stress acquisition model (whether OT or the parameter-setting model) should be a stochastic one.

It should also be noted that even among proponents of the parameter-setting view of L2 phonology, there have been some suggestions that L2 learners may fail to access UG in some subcomponents of phonology (Young-Scholten, 1996). Based on Leather and James's (1991) observation that L2 advanced learners tend to retain a foreign accent even when they have acquired L2 segments and syllables successfully, Young-Scholten suggests that it may be easier to re-set the parameters governing segments and syllables than those related to higher prosodic structure. Our study provides further evidence that in those sub-areas where parameters may not be accessed or reset for some reason, the learning task can still be carried out via other domain-general mechanisms such as statistical learning.

### **5.5. Linguistic/Typological Implications**

After our investigation of the learning mechanisms concerning L2 English stress acquisition by Chinese speakers, it is of interest to return to the discussion of the linguistic and typological implications of this study. Three relevant questions are: (i) do L2 learners whose native language is a tone language acquire L2 English stress in a similar or different way to L2 learners whose native language is also a stress language? (ii) what are the specific effects of a tone language in L2 stress acquisition? and (iii) why are our findings different from Archibald's (1997), which suggested that Chinese subjects could not assign systematic stress patterns to English real words?

Despite the differences of tone and stress in their prosodic systems, we have shown that Chinese speakers acquire English stress in a systematic way. The question that arises then is whether or not this systematic way is similar to or



different from that found in L2 learners whose L1 is also a stress language. In fact, we found that there are several similarities between our Chinese subjects and the Spanish subjects studied by Guion, Harada, and Clark (2004). For instance, our study shows that Chinese speakers' acquisition of the English noun-verb stress contrast may be independent of their acquisition of the stress contrast conditioned by syllable structure. In other words, Chinese speakers are more successful at learning stress patterns by taking the cue of lexical classes than by taking the cue of syllable structure. This tendency is also found in Spanish learners of English. Guion and her colleagues show that while early Spanish speaking learners of English are sensitive to various kinds of information when assigning stress to English nonsense words (e.g., lexical classes, syllable structure and phonological similarity), they also found that late Spanish-speaking learners are sensitive only to lexical class and phonological similarity, not syllable structure. In other words, both Chinese and late Spanish speaking learners of English are not good at using abstract phonological structure in learning L2 English stress patterns. This might suggest that despite the difference between tone and stress, the difficulties which native speakers of stress languages encounter in learning another stress system are similar to those encountered by native speakers of tone languages. In addition, even though late Spanish speaking learners of English are not sensitive to the effect of syllable structure in stress placement, they are able to use other cues in the input data such as lexical classes to help them generalize English stress patterns, which is again similar to what we found in our Chinese subjects. The similarities between Chinese and Spanish speakers suggest that the acquisition of L2 stress by L1 speakers of



typologically different languages (i.e., tone and stress) may be not completely different; rather, the acquisition may be similar in some aspects if not all the same.

In addition, there is the issue of the specific effects of a L1 tone language on L2 stress acquisition. Although we have shown that most of our Chinese subjects acquire the stress placement patterns of English disyllabic and trisyllabic words systematically, this is not to say that these learners have acquired the phenomenon of stress itself. In Juffs's (1990) study he shows that the lexical use of pitch height in tone language has an effect in the acquisition of L2 English stress by native speakers of Chinese. That is, while Chinese uses both pitch height and pitch movement in its lexical tone system, English does not use either in signifying lexical stress. Juffs showed that his Chinese subjects' stress assignment was characterized by high pitch or pitch movement, suggesting that the effect of lexical tone is transferred and the phenomenon of stress has not yet been properly acquired, even though the learners seemed to know the appropriate patterns of stress placement. Relating this to our study, although we have shown that our subjects have acquired stress placement to different degrees, we are not so sure whether they have acquired various phenomena related to stress. For instance, the stressed syllables of the test words in our experiments all carried high pitch because they also happened to be the place where sentence stress was located in our design (e.g., *The nátimpa is white.* vs. *The natimpa is white.*). This might have had the effect of facilitating the perception of stress placement. This possibility cannot be excluded and needs to be tested in further experiments. For example, we can look at whether these L2 learners have problems in determining which syllable is stressed when the information of higher pitch is removed. If they cannot perform the task, it might suggest that the phenomenon of

stress has not successfully been acquired, and would show an effect of L1 tone. In short, the acquisition of stress placement is different from the acquisition of the various attributes associated with stress. More studies need to be done in the area of the prosodic effects of tone and stress in typologically different language pairs.

Regarding the final question, our findings differed from Archibald's in that this study showed that L2 English stress patterns were acquired systematically by Chinese speakers whereas Archibald (1997) concluded that their acquisition was unsystematic. There are several plausible reasons for this. Two have already been discussed in Chapter 2 (Section 2.3.2), namely, (i) sample size (Archibald used only two Mandarin Chinese subjects) and (ii) the lexical status of the test items: Archibald's stimuli consisted of real words rather than non-words, which made it difficult to distinguish between the L2 learners' systematic knowledge of English stress and their item-by-item memorization of the stress pattern of the real words. In addition to these methodological considerations, two additional factors are the homogeneity and the English proficiency levels of L2 subjects. According to the L2 subjects' profiles provided (Archibald, 1997: 170), one of the subjects' English was at Level 3 and the other was at Level 6. The proficiency levels of these learners being so different, it is not surprising that no similar patterns could be found. The groups of subjects in our study were much more homogenous, i.e., consisting of either undergraduate/postgraduate students at the University of Edinburgh (in Chapter 3) or only those learners who had acquired English lax and tense vowels (in Chapter 4). Finally, although the English proficiency levels of the L2 subjects in the two studies cannot be directly compared due to the limited amount of information available, it is unlikely that Archibald's subjects were more advanced than ours. This is mainly

because his subjects were studying at an English language school, whereas our subjects either had test scores which reached the threshold of the language requirements for the University of Edinburgh, or else they had completed the pre-sessional courses of English (over about three months) prior to beginning their study. Again, therefore, it is not surprising that the stress patterns exhibited by Archibald subjects were unsystematic, particularly since his study was designed to investigate the stress patterns which are conditioned by various types of syllable structure – as discussed earlier in this section, late L2 learners are less successful at learning stress contrasts conditioned by abstract phonological structure (i.e., syllable structure).

## 5.6. Chapter Summary

This chapter has discussed which view of the two learning models was better able to explain the patterns of L2 English stress acquisition which we found.

Firstly, it was shown that the parameter-setting account is not able to propose a plausible account of the timing difference between the acquisition of the noun-verb stress contrast, or that of the weight-to-stress mapping of trisyllabic nouns, while, on the other hand, the input-based account could. However, the failure of the parameter-setting model to account for the timing inconsistency need not mean that we must reject this model, since no pattern violating cross-linguistic stress patterns was attested.

Secondly, we discussed the source of the WSP-like patterns in Chinese-English interlanguage. The distribution of the mapping between penultimate syllable type and English stress patterns was presented. There were four types of penultimate syllable (CVVC, CVV, CVC and CV) and two stress patterns (antepenultimate and

penultimate). The stress patterns of trisyllabic nouns in the English input are basically consistent with the patterns predicted by the WSP of UG. That is, when trisyllabic nouns have a light penultimate syllable (CV), stress tends to fall on the antepenultimate syllable, and when trisyllabic nouns have a heavy penultimate syllable (CVC, CVV and CVVC), stress tends to fall on the penultimate syllable. However, the confounding relationship between the abstract WSP and the distribution of English stress placement leads to two equally plausible explanations of L2 English learners' systematic behaviour in our study: it could be said that L2 learners have access to the WSP of UG when they acquire L2 English word stress, but it could also be said that L2 learners generalize the syllable-to-stress patterns based on the probabilistic mapping that exists between syllable types and stress placement in the English input data. When an analysis of the distribution of stress patterns was carried out in more detail – by looking at individual vowels rather than syllable types – the stress mapping with respect to individual vowels (of the same class) was strikingly different. Specifically, lax vowels as a class in the penultimate open syllable (CV) do not always bear antepenultimate stress. When the lax vowel is /ɪ/, the general stress mapping is followed, but when the lax vowel is /ɛ/, the general stress mapping is not followed. In addition, trisyllabic nouns with a CɪC penult do not follow the general stress patterns of  $\sigma$ .CVC. $\sigma$  words as a class, i.e.,  $\sigma$ .CɪC. $\sigma$  words mostly receive antepenultimate stress rather than penultimate stress. In other words, these English stress patterns do not follow the prediction of the WSP, and were therefore able to serve as a testing ground for examining whether learners acquire L2 English stress by triggering the metrical principles of UG or by learning the statistical patterning of the English lexicon. The findings of this study suggest

that our L2 learners were sensitive to the English-specific stress patterning, and that this sensitivity was learned through statistical generalisation.

In addition, we discussed the possibility that despite the difference between tone and stress, L2 learners of these two kinds of languages could have acquired L2 English stress in similar ways, at least in some respects. On the other hand, even if speakers of tone languages can acquire L2 English stress placement, it still remains to be seen whether their L1 tone system has any effect on the acquisition of the phenomena of stress.

Taken together, these findings urge us to re-think a proper model for L2 stress acquisition. Although the parameter-setting model serves as a promising one and has been assumed by many previous L2 stress studies, it is suggested here that the distribution of stress patterns in the ambient language seems to be a more integral part of the knowledge that L2 learners acquire than the parameter-setting model would lead us to expect.



## CHAPTER 6

### CONCLUSIONS AND FURTHER ISSUES

#### 6.1. Conclusions

This thesis has aimed to investigate the learning mechanisms which guide the acquisition of L2 word stress. Having suggested that this issue can be better investigated if the source language is a non-stress language, we determined to observe how native speakers of Mandarin Chinese (a tone language) acquire L2 English stress. Since previous studies in L2 English word stress acquisition by native speakers of Mandarin presented conflicting findings and conclusions, our strategy was first to explore some very basic questions, such as whether or not systematic stress patterns can be found in Chinese learners of English. Based on these findings, we were then able to approach our main concern of learning mechanisms.

By analyzing the data collected from a series of experiments which tested L1 Chinese speakers' stress preferences for English non-words, we have shown that these L2 learners did not acquire English stress on the basis of item-by-item storage; instead, they engaged in some sort of generalization. Furthermore, it was shown that several non-target-like stress patterns from the Chinese subjects can be accounted for either as a universal sonority-weight interaction or as the transfer of the lack of a tenseness contrast in Chinese vowels (i.e., (i) their stronger preference for syllables to be stressed when they were closed by a sonorant consonant rather than an obstruent consonant, and (ii) their stronger preference for closed syllables to be stressed rather than open syllables with a long vowel). Although there were some

different patterns among the individuals, the overall pattern was consistent with the universal tendency for stress to be mapped with syllables that contain a long vowel or a coda consonant. In addition, it was found that AOA serves as a predictor for L2 learners' ability to acquire target-like stress patterns. As for the evaluation of learning mechanisms, evidence from our experiments favours the view that L2 stress acquisition is learned stochastically, based on the distribution of stress patterns in the input data, rather than as a process of simply unfolding the innate metrical principles of UG and setting UG parameters. The arguments are recapitulated as follows.

#### **6.1.1. Stress Generalization**

The starting point of this research was to re-examine a very basic question of L2 English word stress acquisition: can Chinese speakers assign stress to English words systematically? This question was investigated in a series of stress preference tasks, presented in Chapters 3 and 4. Because non-words were used in these tasks, we argued that the learners must have made some sort of generalization if they were able to show stress preferences systematically. The findings, in fact, indicated that our Chinese subjects did show systematic stress preferences for English non-words. In Chapter 3, it was found that 95% of the Chinese subjects (i.e., 19 out of 20) were as sensitive to the noun-verb stress contrast in disyllabic words as the English subjects. In addition, 40% of the same twenty Chinese subjects (i.e., 8 out of 20) were sensitive to the stress contrast which is conditioned by the structure of the penultimate syllable of trisyllabic nouns. In Chapter 4, we identified twenty Chinese subjects who could tell the difference between English lax and tense vowels in monosyllabic words as successfully as English native speakers and administered

another stress preference task, this time with non-words that tested their sensitivity to the universal mapping between stress and syllables which contain a long vowel or a coda consonant. The results showed that although the Chinese group did not show the same pattern as the English controls, they did show a systematic sensitivity to the mapping between stress and four types of syllable structure, defined by the presence/absence of a long vowel or a coda consonant. In addition, the by-subject analysis also showed that 75% of the Chinese subjects (i.e., 15 out of 20) were sensitive to the mapping of stress and syllable structure to varying degrees.

The results of these two chapters taken together suggest that the Chinese subjects made generalizations in acquiring L2 English word stress rather than storing stress on an item-by-item basis even though Mandarin Chinese is traditionally considered as a lexical tone language and does not use the same phonetic cues of lexical prominence as so-called stress languages like English.

### **6.1.2. Evidence for L1 Effects**

Because the Chinese learners' stress preference was generally systematic but not always English-like, we further examined whether or not these systematic but non-target-like patterns could be explained from the perspective of the learners' L1 (and also in terms of language universals; see Section 6.1.3 below).

Two pieces of evidence in the results may be interpreted as the effect of the transfer of Chinese phonological structure. Firstly, Chapter 3 showed that eight of the twenty Chinese subjects were sensitive to the stress difference between trisyllabic nouns with a CV penult and those with a CVC penult. These learners preferred penultimate stress when the penultimate syllable was closed by a consonant, and

preferred antepenultimate stress when the penultimate syllable contained a lax vowel only. Interestingly, their preference was stronger when the post-vocalic consonant was a sonorant rather than an obstruent. This tendency for syllables with a sonorant coda to attract stress more than syllables with an obstruent coda is not found in English, so it must be caused by factors other than the L2. One of the possible explanations is an L1 transfer effect: since Chinese has only CVS syllables (and they are always heavy in content words), the learners may not always know how to deal with CVO syllables, or be sensitive to the weight of CVO in English. However, the L1 transfer account is not unambiguous because the pattern is also consistent with a phonological universal, i.e., sonorant codas tend to be more weight-contributing than obstruent codas (Zec, 1988).

Secondly, the results in Chapter 4 showed that Chinese learners preferred penultimate stress when the penult was CVV, CVC or CVVC, suggesting that the acquisition of L2 English stress follows the universal mapping between syllable structure and stress. However, unlike the English control subjects, the Chinese subjects had a stronger tendency to assign stress to closed syllables. In other words, our Chinese subjects showed less sensitivity to the mapping between stress and long vowels. The result correlated with their non-target-like identification of the *i*/*ɪ* and *e*/*ɛ* contrast in English disyllabic words and can be interpreted as an L1 transfer effect of the lack of contrast between tense and lax vowels in Mandarin Chinese.

These findings indicated that although Chinese and English are typologically different languages in terms of the lexical use of pitch height, the transfer effect is not restricted to the surface difference between lexical stress and lexical tone, and the



L1 effect can occur at more abstract levels of the phonological system (such as vowel contrasts).

### **6.1.3. Evidence for Phonological Universals**

Phonological universals refer here to those patterns that are not attributable to either L1 or L2, but which are still permissible under the terms of the principles and parameters of UG phonology. In this study, we found no unambiguous evidence for phonological universals in the stress patterns of words with two or three syllables in Chinese-English interlanguage. As mentioned in the previous section, the results of Chapter 3 (that the learners had a stronger preference for assigning stress to syllables with a sonorant coda rather than an obstruent coda) cannot be attributed to English stress patterns, yet, while it does seem to reflect the universal effect of sonority-weight interaction, it could also be explained as the effect of L1 transfer due to the lack of CVO syllables in Chinese.

In Chapter 4, the Chinese subjects' stress preferences were generally consistent with a proposed universal mapping of syllable structure and stress. Here again though, although the observed patterns can be explained by the abstract Weight-to-Stress Principle of metrical phonology, one cannot exclude the possibility that the patterns reflect the distribution of stress patterns in English. Therefore in Chapter 5 it was further examined whether the principle-like patterns attested were the product of learners' generalizations over the English input data or whether they reflect the effect of the abstract WSP. The results of our corpus-based analysis did not unambiguously support a role for the abstract WSP, because the distributions English stress patterns also make the same prediction at a very general level (i.e.,



CVVC, CVV and CV tend to be stressed while CV tends not to be stressed). In other words, although these L2 learners' stress patterns followed the universal mapping between syllable structure and stress, the mapping can be explained equally well from the point of view of both the abstract WSP of UG and the distribution of English stress patterns. Therefore, no robust evidence in favour of phonological universals can be reported in this study.

#### 6.1.4. Evidence for Age Effects

In Chapter 3, information such as AOA, LOR, Age, and Language Test Score was collected from the participants to allow us to explore the relationship between these variables and the L2 learners' performance. We found that the variable of subjects' age of arrival in the UK/USA was a useful predictor of the L2 learners' sensitivity to the stress contrast conditioned by the CV vs. CVC penult of trisyllabic nouns (e.g., *Cánada* vs. *agenda*). The younger they were when they first entered the English-speaking community, the more sensitive they were to the stress contrast which maps with syllable structure. This shows that age effects do not only reveal themselves in global accent but also in specific phonological generalizations such as stress assignment in the L2. This also suggests that whatever the learning mechanisms responsible for L2 stress acquisition may be, they are not immune to age effects. Bley-Vroman (1989) (among others) has argued that L2 acquisition takes place via "general problem solving skills". However, the finding that there is such a clear age effect in L2 stress acquisition suggests that what is involved in L2 phonological acquisition cannot be any type of general learning mechanism that is usually thought to immune to biological maturation.

### 6.1.5. Learning Mechanisms

After exploring how systematic patterns were related to linguistic factors (L1 and phonological principles) and non-linguistic factors (including AOA and LOR), the main concern of this thesis was addressed in Chapter 5, namely, the learning mechanism which guides the acquisition of L2 English stress by native speakers of Chinese. Two general views were discussed, the UG-based parameter setting model and the input-based statistical learning model. We examined which of these options is more likely to be the one which guide the acquisition of L2 stress by the Chinese learners given two major findings of this study: (i) the noun-verb stress contrast is acquired no later than the stress contrast conditioned by the CV and CVC penult in trisyllabic nouns, and (ii) the learners acquire the universal mapping between stress and syllable structure.

Firstly, the timing difference between L2 learners' sensitivity to the noun-verb stress contrast in disyllabic words with a CVCC final syllable and their sensitivity to the stress contrast in trisyllabic nouns with a CVC vs. CV penult runs counter to the predictions of the parameter-setting model. If the learners acquired the noun-verb stress contrast via parameter-setting, they should also have acquired the weight implications of CV and CVC. So they should also have acquired the stress contrast in trisyllabic nouns, since that contrast is also conditioned by the CV/CVC distinction. However, this is not what we observed in the data. The pattern which we did observe can only be explained by the statistical learning model, which allows independent learning of the noun-verb stress contrast via statistical learning.

The other finding was that L2 learners' preference for penultimate stress of trisyllabic nouns was basically consistent with the prediction of the universal WSP,

which can be interpreted as the successful setting of metrical parameters, i.e., Quantity-sensitivity [QS] and Quantity-sensitive-to [Rhyme]. This might be taken in support of the view that stress acquisition is primarily mediated by the innate metrical principles and parameters of UG (e.g., Pater, 1997). However, since English is a quantity-sensitive language and its stress patterns generally follow the WSP, we cannot exclude the possibility that L2 learners learn the stress patterns from the statistical distribution of input data. In order to test this, we examined the distribution of English stress patterns by checking the distribution of the stress patterns of the English trisyllabic nouns in the CELEX database. The corpus-based analyses show that, at the very general level, words which have the patterns  $\sigma$ .CVVC. $\sigma$ ,  $\sigma$ .CVV. $\sigma$ , and  $\sigma$ .CVC. $\sigma$  tend to have penultimate stress, whereas  $\sigma$ .CV. $\sigma$  words tend to have antepenultimate stress. In other words, the two learning views make the same prediction for the acquisition of the mapping between the two stress patterns and the structure of the penultimate syllable. However, a more detailed corpus-based analysis of the stress patterns in trisyllabic nouns, taking into account the individual vowels, revealed two facts which allowed us to evaluate the two views of learning. One comes from the stress patterns of  $\sigma$ .C $\epsilon$ . $\sigma$  words, which the WSP predicts to have antepenultimate stress, but whose distribution in English is that they tend to have penultimate stress. The other involves  $\sigma$ .CiC. $\sigma$  words, which are predicted to have penultimate stress by the WSP, but which turn out to have antepenultimate stress. The results of the L2 learners' preferences in Chapter 4 can be characterized better by the input-based statistical learning model rather than the UG-based parameter setting.

In summary, the finding that the acquisition of the noun-verb stress contrast occurs no later than the acquisition of the stress contrast conditioned by the structure of the penultimate syllable poses a problem for the parameter-setting account. This pattern can only be explained by the input-based statistical learning model, which allows the noun-verb stress contrast to be learned independently of the contrast conditioned by the structure of the penult via statistical learning. Another type of data that favours the input-based account comes from the corpus-based analysis of segmental effects on English stress, which shows that penults tend to be stressed when they contain a certain kind of vowel, regardless of syllable structure. Although we cannot draw decisive theoretical conclusions from the results attested in this study alone since the data are very limited, what can still be emphasized is that the acquisition of L2 stress patterns is more complicated than the standard parameter-setting model would predict.

#### **6.1.6. Linguistic/Typological Implications**

As for the linguistic and typological implications of this study, we discussed two issues: (i) do L2 learners whose native language is a tone language acquire L2 English stress in a similar or different way to L2 learners whose native language is also a stress language? and (ii) what are the specific effects of a tone language in L2 stress acquisition?

Regarding the first question, despite differences in prosodic systems between tone and stress, we found that there are several similarities between our Chinese subjects and Guion, Harada and Clark's (2004) Spanish subjects. For instance, both Chinese and late Spanish speaking learners of English are not good at using abstract



phonological structures in learning L2 English stress patterns. The similarities between Chinese and Spanish speakers suggest that the acquisition of L2 stress by L1 speakers from typologically different languages (i.e., tone and stress) may be not completely different; rather, the acquisition may be similar in some aspects if not wholly the same.

Although there are similarities in L2 stress acquisition between native speakers of stress languages and native speakers of Chinese, this does not mean that Chinese speakers can acquire all the phenomena related to stress. Although we have shown that most of our Chinese subjects are able to acquire the stress placement patterns of English disyllabic and trisyllabic words systematically, this is not to say that these learners have acquired the phenomena of stress itself. As reported by Juffs (1990), the lexical use of pitch height and pitch movement in tone languages has an effect on the acquisition of L2 English stress by native speakers of Chinese. That is, Chinese speakers tend to over-rely on pitch height and pitch movement in the realization of L2 stress. Although we have shown that our subjects have acquired stress placement to different degrees, it remains to be tested whether or not they have also acquired the various phonetic phenomena related to stress. In short, although it is suggested that stress placement is learnable by native speakers of tone languages, it is still not clear to what extent the lexical use of pitch in the learners' L1 influences their acquisition of the various phenomena of stress as a whole.

## **6.2. Further Issues**

An issue that has not been fully addressed in this research is the influence which the presence/absence of segmental contrasts in the L1 (e.g., long/short vowels and



obstruent codas) might have on the timing of stress development. The weight-to-stress principle, which is thought to be parameterized in language, is sensitive to vowel types and coda consonants in English, but both of these have to be learned by Chinese speakers. If these two cues were available for learners from the input, then the probability of acquiring the two factors which govern the English stress system should be equal. However, the data from this study show an asymmetrical effect. A general observation is that if a learner's L1 does not have the tense/lax (or long/short) vowel contrast, they will also have more difficulty in perceiving the weight contributed by long vowels when determining stress. To test this hypothesis, more cross-linguistic studies need to be conducted to compare L1 segmental differences and their relative scheduling in L2 metrical acquisition. For example, the emergence of the vowel weight contrast (i.e., heavy/long vs. light/short) is predicted to be earlier in languages which have the same lax/tense vowel contrast as English has.

In addition, studies of L2 vowel acquisition have shown that L2 vowels are difficult to acquire even for very advanced learners. We also showed that the fragility of L2 vowels influences the acquisition of the mapping between stress and syllables with a long vowel to a great extent. We wonder if this kind of learning difficulty can be reduced. Some studies have shown that the perception and production of L2 vowels can be trained in the laboratory, and the effectiveness of such training in Chinese-speaking learners of English has been reported by several studies (e.g., Wang, 2002). It may also be interesting to investigate further whether or not training can also be effective at, and extend to, higher metrical levels and processes such as stress assignment.

Another phenomenon attested in this study was that the Chinese subjects seemed to treat sonorant codas as heavier than obstruent codas. We could not discriminate between the effects of L1 transfer versus the effects of metrical universals as the explanation for this phenomenon in this study: in order to clarify which analysis is likely to be true, again, we need more data from L2 learners who have other languages as their L1. In particular, we should look at an L1 that allows both sonorant and obstruent codas. If L2 learners whose L1 allows both types of coda consonants do not show a preference for sonorant codas rather than obstruents, then we will be able to say more confidently that the tendency exhibited by our Chinese subjects can be attributed to L1 transfer. On the other hand, if the speakers of the two languages acquired L2 English stress in the similar way, say, being sensitive to sonorous coda consonants more than to obstruent coda consonants, then other explanations such as the effect of the universal sonority-weight relationship might be possible.

Finally, the data collected here did not capture the emergence of stress patterns in the stages in which the tense/lax vowel contrast of monosyllabic words has not been acquired. The four developmental patterns identified in Chapter 4 were attested by learners who had met the prerequisite of being able to distinguish English tense and lax vowels. However, the stress assignment behaviour of learners who cannot successfully identify tense and lax vowels is not clear. Although the sensitivity to coda consonants is used to merge the findings of Chapter 3 and Chapter 4 (i.e., when learners are sensitive to coda weight they must be sensitive to the noun-verb stress contrast), whether sensitivity to the mapping of stress with syllables with a coda consonant emerges before or after the acquisition of native-like vowel

identification is not clear in our study; that is, whether, at the stage in which learners cannot reliably identify lax/vowel vowels, they can perceive the weight of coda consonants without being able to perceive the weight of lax and tense vowels.

It is hoped that this research constitutes an important step towards understanding the mechanisms that underlie L2 phonological development. Although there are still many issues to be explored, it is clear that this research on L2 stress acquisition by L1 speakers of a tone language provides valuable insights into the nature of L2 prosodic development.

APPENDIX 1. NON-WORDS USED IN CHAPTER 3

Disyllabic non-words used in the preference task

Type 1: CV.CVCC (nouns)			Type 2: CV.CVCC (verbs)		
Visual stimuli	Auditory stimuli		Visual stimuli	Auditory stimuli	
	Final stress	initial stress		Final stress	initial stress
dosept	/dəsépt/	/dósept/	zocept	/zəsépt/	/zósept/
kasect	/kəsékt/	/kásekt/	vercept	/vəsépt/	/vérsept/
fercept	/fəsépt/	/fǽrsept/	dresect	/drəsékt/	/drásekt/
togest	/təgést/	/tógest/	magest	/məgést/	/mágest/
varect	/vərəkt/	/værekt/	vorect	/vərəkt/	/vórekt/
bergest	/bəgést/	/bærgest/	nagest	/nəgést/	/nágest/
fermect	/fəmékt/	/fǽrmekt/	bozent	/bəzént/	/bózent/
shalent	/ʃəlént/	/ʃælént/	malect	/məlékt/	/málekt/
Example of carrier sentences:			Example of carrier sentences:		
The ____ is [blue/red/white/black/pink].			[He/She] is easy to ____.		

Trisyllabic non-words used in the preference task

Type 3: CV penult			Type 4: CVC penult		
Visual stimuli	Auditory stimuli		Visual stimuli	Auditory stimuli	
	óσσ	σσσ		óσσ	σσσ
natipa	/nátipə/	/nətipə/	bemfimpus	/bénfimpəs/	/bənfimpəs/
sebilka	/sébikər/	/səbikər/	natimpa	/nátiməpə/	/nətiməpə/
panitus	/pənitəs/	/pənítəs/	vepilka	/vépɪlkə/	/vəpɪlkə/
pefira	/péfɪrə/	/pəfɪrə/	basilka	/bəsiləkə/	/bəsɪlkə/
terimy	/térimɪ/	/tərími/	tobitla	/tóbitlə/	/təbitlə/
tokifer	/tókɪfər/	/təkífər/	trufidla	/trúfɪdlə/	/trəfɪdlə/
varimi	/vərimɪ/	/vərími/	pemisto	/pémisto/	/pəmísto/
kabikus	/káɪbɪkəs/	/kəbíkəs/	natiskus	/náɪɪskəs/	/nəɪískəs/
Example of carrier sentences:					
The ____ is [blue/red/white/black/pink].					



## APPENDIX 2. SIMILARITY TASK IN CHAPTER 3

Participants were given the following instructions:

Please read the following words. Your task is to write down as many words as you can come up with which are similar to the English words you know. Don't worry how many words or what types of words you can think of. You have just two minutes for the task.

natipa	
sebika	
panitus	
pefira	
terimy	
tokifer	
varimi	
kabikus	
bemfimpus	
natimpa	
vepilka	
basilka	
tobitla	
trufidla	
pemisto	
natiskus	

### APPENDIX 3. MONOSYLLABIC WORDS USED IN THE SCREENING TEST IN CHAPTER 4

/ɪ/-/i/ contrast		/ɛ/-/e/ contrast	
sit-seat	is-ease	met-mate	pest-paste
dip-deep	live-leave	bet-bait	less-lace
ship-sheep	bit-beat	tell-tail	men-main
slip-sleep	rich-reach	fed-fade	pen-pain
it-eat	pitch-peach	led-laid	Ken-cane
pick-peak	fill-feel	test-taste	sell-sale

APPENDIX 4. NON-WORDS USED IN CHAPTER 4

Non-words Targeting the Stressability of the Final Syllable of Disyllabic Verbs

1.     stressed final syllable			2.     stressed final syllable		
long	vs.	short	closed	vs.	open
kə́tí		kətí	səlíg		səlǐ
nə́fí		nəfí	də́mǐd		də́mǐ
və́rí		vərí	rə́dǐl		rə́dǐ
sə́pí		səpí	rətʃǐl		rətʃǐ
sə́lǐ		səlǐ	tə́gǐl		tə́gǐ
pə́rí		pərí	nə́pǐtʃ		nə́pǐʃ
bə́kǐ		bəkǐ	sə́kǐg		sə́kǐ
mə́dǐ		mədǐ	rə́kǐt		rə́kǐ
və́ré		véré	lə́kév		lə́ké
sə́ré		séré	rə́hén		rə́hé
fə́gé		fəgé	nə́réz		nə́ré
mə́pé		məpé	zə́pétʃ		zə́pétʃ
rə́dé		rədə	rə́néɪ		rə́né
pətʃé		pətʃé	mə́pét		mə́pé
kə́ré		kéré	tətʃél		tətʃé
fə́ré		féré	pətʃél		pətʃé

Example of Carrier sentences: We/they/I often \_\_\_\_\_ them/him/her.

## Non-words Targeting Rightward Stress Shift in Trisyllabic Nouns (Four types)

1. CVVC penult		2. CVC penult	
stressed antepenult	stressed penult	stress antepenult	stressed penult
/kæbintən/	/kəbintən/	/bénfimpəs/	/bənfimpəs/
/pífimrə/	/pəfimrə/	/nætɪməpə/	/nəɪməpə/
/tísilkə/	/təsilkə/	/vépɪlkə/	/vəpɪlkə/
/néziltəs/	/nəziltəs/	/bæsɪlkə/	/bəsɪlkə/
/nætiskəl/	/nətsikəl/	/tóbitlə/	/təbɪtlə/
/pómistəl/	/pəmístəl/	/trúfɪdlə/	/trəfɪdlə/
/kóritni/	/kəritni/	/pémɪsto/	/pəmísto/
/təniktən/	/təniktən/	/nætɪskəs/	/nəɪskəs/
/détəmpə/	/dətəmpə/	/kæbentən/	/kəbéntən/
/bæselkə/	/bəselkə/	/pífəmrər/	/pəfəmrər/
/vípelkə/	/vəpélkə/	/tíselki/	/təsélki/
/méneslə/	/mənéslə/	/pénzeltəs/	/pənzéltəs/
/tóbeslər/	/təbéslər/	/nætɛskəs/	/nəɛskəs/
/tínətlər/	/tənétlər/	/pómestəl/	/pəméstəl/
/péfədlə/	/pəfədlə/	/kórətməl/	/kərétməl/
/bótempər/	/bətémpər/	/tánektən/	/tənéktən/

3. CVV penult		4. CV penult	
stressed antepenult	stressed penult	stress antepenult	stressed penult
/dézitəs/	/dəzítəs/	/nætɪpə/	/nətípə/
/vəbirə/	/vəbírə/	/séɪkər/	/səbíkər/
/məsitər/	/məsítər/	/pænɪtəs/	/pənítəs/
/fætɪdʒən/	/fətídʒən/	/péfɪrə/	/pəf'írə/
/təbɪdər/	/təbídər/	/térɪmi/	/tər'ɪmi/
/fɛkilən/	/fəkílən/	/tókɪfər/	/təkífər/
/fænítər/	/fənítər/	/vərɪmi/	/vər'ɪmi/
/nésɪdər/	/nəsídər/	/kæɪkəs/	/kəbíkəs/
/pézetəl/	/pəzétəl/	/trɪsɪtəs/	/trəsétəs/
/vímerər/	/vəmérər/	/píberə/	/pəbéərə/
/nósedi/	/nəsédi/	/mídɪtəs/	/mədétəs/
/fɪpekər/	/fəpékər/	/fótɪdʒən/	/fətédʒən/
/míbetən/	/məbétən/	/tíbɪdər/	/təbédər/
/síketən/	/səkétən/	/dætɪlən/	/dətélən/
/fɪnemər/	/fənémər/	/fɪnɪdər/	/fənédər/
/dréferər/	/drəferər/	/mónɪfər/	/mənéfər/

Example of carrier sentences: The \_\_\_\_\_ is red/blue/white/black/light/dark.



**APPENDIX 5. DISYLLABIC WORDS USED IN THE VOWEL IDENTIFICATION TASK**

/ɪ/ -/i/ contrast		/ɛ/-/e/ contrast	
bitter-beater	hitting-heating	pepper-paper	testing-tasting
ripper-reaper	wicker-weaker	letter-later	seller-sailor
slipper-sleeper	sicker-seeker	wetter-waiter	teller-tailor
chipper-cheaper	stilly-steely	getter-gaiter	belly-bailey
sitting-seating	filling-feeling	beckon-bacon	Kelly-ceilidh
dipper-deeper	liver-lever	redder-raider	deli-daily

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